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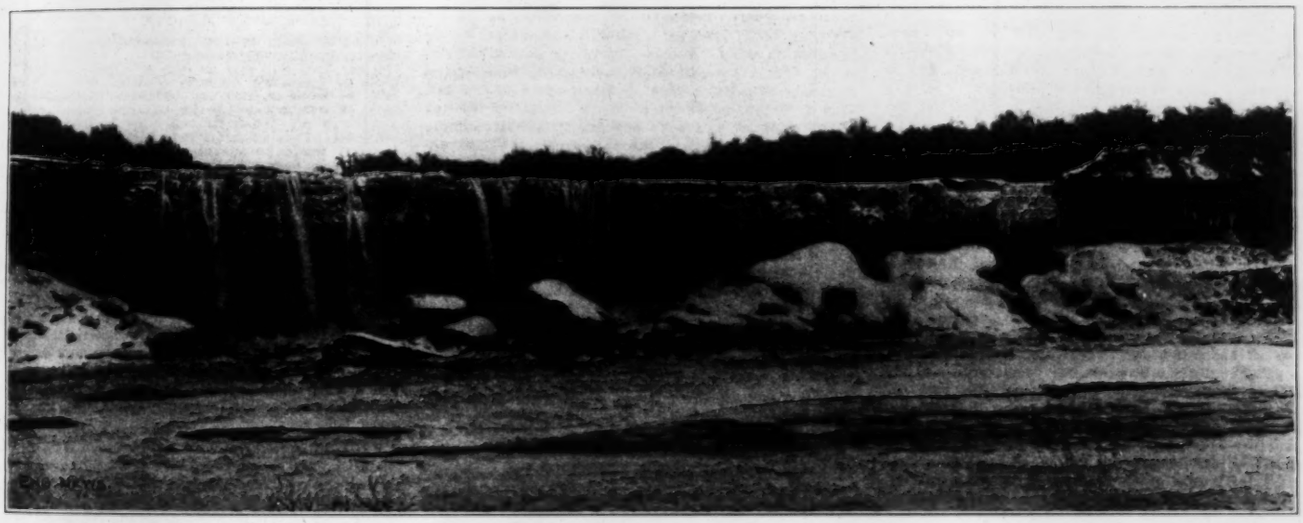
A Dry Niagara.

By WILLIAM G. BROADHURST.*

The American Falls at Niagara were practically dry on Feb. 14, 15 and 16, and the total flow of water through Niagara River in the Upper Rapids between Goat Island and the New York mainland, would not have made a good sized brook. Ice nearly spanned the rapids and people walked about on it. Indeed, four men in rubber boots walked across the brink of the falls from the mainland to Goat Island.

A northeast wind of varying velocity blew continuously from Friday, Feb 12, until the night of Tuesday, Feb. 16. On Saturday the water put was below normal, but with the help of the Canadian company, under the same management, the customers were supplied so as not to be inconvenienced to any great extent. The Niagara Falls Hydraulic Power and Manufacturing Co. takes its water from the Niagara River through a canal which starts at a point about half a mile above Goat Island. This was right in the ice field, but the water was not much obstructed at this point by the ice, and the water level in the canal was only 3 ft. below normal on Tuesday. The company was able to supply all of its customers with power all of the time. However, the surplus power which some of its customers had been taking was cut off, and in one case one customer ran for five to



THE AMERICAN FALLS AT NIAGARA, FEB. 16, 1909.

in Niagara River began to lower perceptibly, as it was blown back into Lake Erie. By Saturday night the ice coming down the river had jammed across from Goat Island to the New York mainland, and it backed up the river for a mile, forming an almost impermeable dam. The low water also allowed the ice to form on the Goat Island side of the Canadian or Horse Shoe Falls for 200 or 300 ft. out from the island. The water flowing over these falls was less than half the normal amount.

The power manufacturing companies generating electrical power here were affected by the low water, but not very severely. The forebay of the Niagara Falls Power Co. is so far above Goat Island that it was affected by the ice, but little more than is usual in winter. The water in the forebay was about 3 ft. lower than normal on Tuesday, Feb. 16, which was the worst day. For a few hours at a time the out-

six hours on 80% of the usual power. This is the first time that either power company has been affected to any extent in this way. There has been some trouble with ice in the forebays but the water level has never been lowered in them by unusual winds or by blocking of the river.

The intake of the auxiliary fire system of one of the works on the bank of the river was left high and dry for a few hours, and similar incidents occurred, but all without serious results. On the Canadian side there was no ice, but the water level was also below normal; the power output was affected even less than on the American side.

Only twice before, since any official record has been kept, has this condition occurred. In March, 1848, and again in March, 1903, but neither time for so long a period as this one. The ice jam broke up on Feb. 18, under the combined effect of mild weather and a change in the direction of the wind, and Niagara was restored to its usual magnificence.

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The Valuation and Inspection Work of the Joint Engineering Staff of the Wisconsin Tax and Railroad Commissions.*

By WM. D. PENCE,† M. Am. Soc. C. E.

The engineering staff which jointly serves the Wisconsin Tax Commission and the Railroad Commission of Wisconsin was organized in 1903, under authority of the law providing for the assessment of the steam railway properties of the state on an ad valorem basis. In 1906 the first engineer for the Tax Commission resigned, and his successor was appointed to render joint service for the Tax Commission and the then recently created Railroad Commission of Wisconsin.

The 1905 law prescribing the ad valorem basis of assessment for street railway properties provided for the valuation work to begin on June 30, 1907, but the work was actually undertaken some six months earlier because of a complaint lodged with the Railroad Commission respecting street car fares in Milwaukee. To meet this emergency, the staff was reorganized and greatly extended in January, 1907. Since then, a staff of from 20 to 30 members has been required continuously to meet the joint demands of the two commissions. Immediately upon the completion of the Milwaukee valuations in July, 1907, the field work for the valuation of the physical property of the remaining street railway and associated lighting companies of the state was undertaken. Before the completion of that work, active service under the newly enacted public utilities law was inaugurated.

The following is a brief outline of the several laws under which authorization or necessity for the use of a technical staff serving the two commissions has arisen:

1. The Tax Commission Law (Wis. laws, 1905, chap.

*Abstract of a paper read before the Western Society of Engineers, at Chicago, Dec. 16, 1908. The paper will be published in full in the "Journal" of the society (Monadnock Block, Chicago).

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380).—A state tax commission was created as early as 1897. Its powers were extended by successive legislatures until 1905, when the permanent State Tax Commission was organized on its present basis.

2. The Railway Commission Law (Wis. laws, 1905, chap. 362).—This created the Railway Commission of Wisconsin and defined its powers with reference to the regulation of rates and service of the common carriers of the state. With certain extensions enacted in 1906 and 1907 the law was made to apply to railways, street railways, express and telegraph companies.

3. The Steam Railway ad valorem Assessment Law (Wis. laws, 1903, chap. 315).—This provides for the taxation of steam railways or common carriers incorporated under the general railway law on the ad valorem plan, instead of the gross earnings basis which had prevailed for many years previous to 1903.

4. The Street Railway ad valorem Assessment Law (Wis. laws, 1905, chap. 493).—This substitutes the ad valorem for the gross earnings basis in the taxation of so-called "street railway" properties, and for such lighting and heating plants as may be operated in association therewith.

5. The Public Utilities Law (Wis. laws, 1907, chap. 499).—This confers upon the Railroad Commission regulative powers similar to those of the 1905 Railroad Commission law, applicable to all properties engaged in the conveyance of telephone messages or in "the production, transmission, delivery or furnishing of heat, light, water or power either directly or indirectly to or for the public," and whether publicly or privately owned and operated.

6. Stock and Bond Issue Law (Wis. laws, 1907, chap. 576).—This provides for supervision by the Railroad Commission of the issue of stocks and bonds of "public service corporations."

7. Public Convenience and Necessity Law (Wis. laws, 1907, chap. 454).—This provides that a railway corporation must secure from the Railroad Commission, in advance of construction or other preliminary step, a "certificate that public convenience and necessity require the construction of said railway." Among the powers conferred upon the Commission is the control over the manner of crossing other railways.

8. Two-Mile Industry-Track Law (Wis. laws, 1907, chap. 352).—This provides for the construction of tracks to industries located within two miles of a railway, at the expense of the owner of the industry, provided the operation of the track would not be "unusually unsafe and dangerous." Provision is made for appeal to the Railroad Commission where railways upon application refuse to construct such tracks.

9. The Wisconsin Valley Improvement Company Law (Wis. laws, 1907, chap. 335).—This authorizes the formation of an association of all owners of water powers along the Wisconsin River for the purpose of establishing extensive reservoirs at the headwaters for the conservation of the water supply. Provision is made that certain reports covering the affairs of the association be submitted semi-annually to the Railroad Commission and that certain administrative functions be performed by the Commission.

The services of an engineering staff are also occasionally brought into requisition under other Wisconsin laws besides those outlined above. Among these may be mentioned the law relating to the protection of railway crossings and drawbridges, and that providing for the installation of bridge warnings or tell-tales.

Organization of Engineering Staff.

The staff engaged in the 1903 steam railway valuation work was organized under three general chiefs of departments, respectively responsible to the chief engineer for the valuation of (1) the permanent way, (2) the lands, and (3) the mechanical features. With the reorganization for the purpose of making the street railway valuations, there were still but three heads, the land valuations being associated with the first or "roadway" group, and an electrical department added. Under the still wider scope to the work of the staff arising under the administration of the public utilities law within the past year or so, the civil and mechanical engineering groups have been extended to cover water-works plants; and the electrical engineering group to include telephones. Two additional groups or departments have been established: (1) gas engineering, and (2) the department of gas and electric service inspections. The duties of these several departments of service as outlined below cover all phases of the work of the two state commissions.

1. Administrative.—Consisting of the engineer, assistant engineer and heads of departments, responsible for the direction of the work.

2. Office Staff.—Engaged in the reduction of field notes, the compilation of valuation and other reports, and the systematic collection and filing of cost data and other records.

3. Civil Engineering Staff.—Engaged in the inspection and valuation of those details of the physical property of steam and electric railways and public utilities plants which are customarily purchased, constructed, or maintained under the direction of civil engineers. Also investigations, in cooperation with other departments, with a view to suggest improvements in the operating conditions of railways, water-works plants, etc.

4. Mechanical Engineering Staff.—Engaged in the inspection and valuation of those details (as above) which are customarily under the direction of mechanical experts or engineers. (Also investigations, in cooperation with other departments, as under No. 3.)

5. Electrical Engineering Staff.—Engaged in the inspection and valuation of those details which are usually under the direction of electrical experts or engineers.

6. Gas Engineering Staff.—Engaged in the inspection and valuation of machinery and appliances for the manufacture of gas.

7. Gas and Electric Service Inspectors.—Engaged in inspections and investigations of gas and electric service; studies with reference to the establishment and revision of standards of service and the formulation of rules for the same; tests and calibrations of instruments used in service measurements, investigations with reference to the electrolysis of water and gas mains, etc. Also investigations, in cooperation with other departments, with a view to suggest improvements in the operating conditions of gas and electric plants.

8. Miscellaneous.—Experts engaged temporarily for special service of various kinds, either independently or in cooperation with one or more of the foregoing departments. Such service hitherto rendered has included such matters as the following: Consultation with prominent architect relative to valuation of a costly city building; service of expert in investigations as to the safety of an important bridge; expert valuation of the horses, harness, etc., belonging to a large electric railway and lighting company; expert assistance in establishing a basis for valuing street railway special work, etc.

The basis of appointment of the staff is provided for in part by a formal rule of the Civil Service Commission, and in part by special authorizations given from time to time by the Railroad Commission for the employment of experts under the provisions of the public utilities and railroad commission laws. Membership is based upon ascertained fitness for the special service for which the appointment is made. There is entire freedom from political or other influence both in the matter of appointment and in the tenure of position on the staff. The tenure of service has been steady, the roll, except for the additions, being much the same as that established early in 1907. The practice followed by the Railroad Commission in its other departments of service of requiring each employee to report daily the actual hours devoted to the state work, is observed by the technical staff.

The present membership of the technical staff consists almost exclusively of graduates of engineering schools, and about 60% of the permanent staff are graduates of the University of Wisconsin. Seven members of the regular staff are also members of the faculty of the College of Engineering, University of Wisconsin. Among this number are the engineer in charge, the chief mechanical inspector and the expert on light and heat. Five other members of the teaching force of the engineering college render occasional service on the commissions' staff. This is but one of many instances in Wisconsin of active participation by university men in professional service on behalf of the state. Such participation is encouraged by the Board of Regents and President of the University both on account of a recognized obligation to the state which provides support, and because of the stimulus given to the work of the University through outside contact of this kind.

Valuation Work by the Staff.

The valuations reported to the commissions by the engineering staff have been confined throughout to the physical property, without regard to intangible elements. For a given inventory covering the items of any particular property, a definite value is fixed upon a fair basis as to unit prices, etc., and the results are reported by the staff at a definite amount, irrespective of the uses to which the figures are to be applied. These determinations are, by intention, entirely free from bias. Every reasonable effort is made to get at the exact truth in regard to local conditions. The figures are subject to revision upon finding evidence of defects of inventory, errors of judgment, or other element likely to vitiate results. After submitting the valuation reports to the commission, opportunity is given for further conference and hearing upon any or all items of the physical valuation.

In certain public utilities cases the owners, and in a few cases the cities as well, have employed experts to give testimony on values before the Railroad Commission. In one or two cases the state engineering staff has submitted to the representatives of the utilities company and the city an "informal" valuation report to serve as a basis for preliminary conference and discussion. This preliminary report, after due consideration in the light of added data and information is succeeded by the "tentative" valuation report which is submitted to the Railroad Commission as a part of the formal record in the case to be considered with other evidence. Before making up a final decision in the case, the Commission gives the engineer an opportunity to review the record and submit a supplementary report, in which are presented revisions or comments bearing upon the original or "tentative" valuation report.

The valuation work performed by the engineering staff falls under four heads: (1) The physical property of the steam railways of the state; (2) the street railway and associated properties; (3) the public utilities properties, and (4) public service corporation properties in connection with stock and bond issues.

Valuations of Physical Property of Steam Railways.

The Tax Commission, by authority given in section 27 of the steam railroad assessment law, on June 3, 1903, appointed as its expert engineer Prof. Wm. D. Taylor,* Professor of Railway Engineering, University of Wisconsin. Under instructions from the Commission, Mr. Taylor consulted with Prof. Mortimer E. Cooley, of the University of Michigan, under whose direction the Michigan railway appraisals of 1900-1901 had been made. Acting upon the information and v... furnished by Mr. Cooley, the preliminary Wisconsin appraisals were developed ... short time, and certain features of th... were improved upon.

The most important difference in ... in the two state appraisals related ... working out the inventories and to th... the state staff made actual detailed ... the physical property. In the Michi... state staff took the initiative in prepari... and made extensive and independent ... of the railway property. This work ... duplicated by the companies themselv... to check up the figures obtained by t... some extent a third process was req... compilations, in order to reconcile the ... independent appraisals.

With a view to eliminate this costl... unnecessary repetition of work, the Wis... mission, upon the advice of its engineer, ... representatives of the important railw... that the companies undertake to inventor... own properties for submission to the Boa... gestion the companies readily assented, ... of work subsequently adopted it was ... portion or all of the inventoried properties might be reviewed by the state staff, according to ... the commission's engineer. Such review ... tion when finally made fully confirmed ... spirit of good faith with which the representatives of ... railways responded to the open-minded attitude of ... Commission and its engineer towards the companies. It may be added that the spirit of fairness inaugurated in the initial appraisals has prevailed throughout the successive annual revisions of the steam railway valuations.*

Mr. Taylor at the conclusion of his report to the State Board of Assessment above referred to, makes the following comment with regard to the matter of keeping the valuations up to date by annual revisions:

It should not ever again be necessary to make as expensive an investigation as this has been to determine the value of the tangible railway property of the state. And if the future assessments for taxation are to be in any wise determined by the value of railway physical property, and if a rate-making railway commission is to be constituted in the state which shall give any weight whatever to the investment in physical property in deciding upon rates for freight and passenger traffic, it will be necessary to keep the appraisal of these properties reasonably well up to date.

It has been said that no item of railway property, tangible or intangible, remains constant in value. Traffic and the value of land and terminals fluctuate with the tide of business prosperity. Rolling stock, rail, and structures all depreciate and the roadbed appreciates with use. Thus it seems that with this appraisal as a basis it would be advantageous to work the appraisal of the roads over again annually. Counting upon the assistance of the railroads this can be done with a comparatively small force and at comparatively small annual expense.

In line with the foregoing plan the engineer had previously supplied to each railway company a copy of the detail summary sheets pertaining to its property. Early in 1905 he sent to each road two sets of blank report forms relating to the physical property in detail, stamped respectively "Deductions from property June 30, 1903, to June 30, 1904," and "Additions to property June 30, 1903, to June 30, 1904." These blanks when filled out and returned to the engineer, formed the basis of revisions of the original appraisals of 1903, whereby the valuations were brought up to the second inventory date of June 30, 1904.

PROPOSED REVISIONS OF METHODS.—In the 1903 plan, the cost of reproduction was "assumed to be what it would cost to reproduce the road at the average prices prevailing for the period of five years ending June 30, 1902" (that is, one year preceding the date of inventory). Through the excellent spirit of cooperation which pervaded the 1903 valuation work, a series of unit prices based on the above assumption was worked out and adopted. While it has been practicable to make annual revisions in the unit prices for steel rails and a few similar materials subject to current market quotations, there have been no systematic revisions in the unit prices with respect to many kinds of the physical property involved in the inventories of the steam road properties. Five years have elapsed since these valuations were undertaken, and during this period there have been many radical changes in the cost of labor and materials involved in railway construction. Notwithstanding the temporary reaction in prices during the past year or so, it is certain that some important items, such as ties and structural timber, will never resume their former basis of cost.

Another matter which requires careful consideration in this connection is the advance in land values throughout the state. No account has been taken of this factor in the annual revisions, the land values originally established having been used without change in the annual re-valuations. There is also need to investigate further the matter of ratio of cost of acquiring rights-of-way

*Prof. Taylor served as engineer to the Wisconsin State Board of Assessment until Feb. 1, 1906, when he resigned to become Chief Engineer of the Chicago & Alton Ry. His successor was appointed on July 1, 1906, to serve the two state commissions jointly.

*A very complete presentation of the methods employed was published in the report of the Wisconsin Tax Commission, 1907; pp. 209-296.

as compared with normal or average local land values for other than railway purposes. These studies should be carried still further to cover the cost of acquiring lands for terminal purposes in the larger cities.

A critical study of the methods heretofore used in the valuations in Wisconsin and other states is being made by the staff with a view to recommend improvements upon the present practice wherever practicable. These revisions of method may be carried into effect, at least in part, in making the next (six) steam railway valuations, for the year ending with June, 1908.

Valuation of Milwaukee Street Railway Properties.

The steps leading up to the valuation of the street railway properties of the state for the purposes of the two commissions have already been mentioned. Mr. Bion J. Arnold, of Chicago, was called in consultation and arrangements were made whereby several members of the special staff previously engaged under his direction in the Chicago valuation work were transferred temporarily for service on the Wisconsin engineering staff. It was the original idea that the street railway company should furnish a complete inventory of its property. Certain delays occurred which led to a change in plan, whereby the state engineering staff undertook the preparation of the inventory from the company's records and by field examinations.

The final report included the entire property owned by the Milwaukee companies, known locally as the "Beggs properties": (1) the city railway lines (123.6 miles), and the associated lighting properties (the Milwaukee Electric Railway & Light Co.); (2) the country or interurban railway lines (144.2 miles), and the associated lighting properties at Racine and elsewhere (Milwaukee Light, Heat & Traction Co.); (3) the Milwaukee steam heating company (the Milwaukee Central Heating Co.) The total physical valuation, including all the properties mentioned above for the inventory date of Dec. 31, 1906, amounted to $18,435,960 for the property new, and $14,864,849 for the property in existing condition.

Physical Valuation of Other Street Railway Properties.

Immediately upon the completion of the formal report upon the Milwaukee valuation, the field work for the valuation of the remaining electric railway lines of the state was undertaken. The size of the staff was somewhat reduced and the organization modified in some respects to meet the varying conditions. Of these additional electric railway lines, numbering in all 22 properties, about half are operated in association with public utility properties supplying electric lighting and power service.

As already stated, this field work on the street railway properties chanced to be undertaken immediately after the enactment of the public utilities law (July, 1907) and it was then foreseen that the results of such work might ultimately be required by the Railroad Commission in rate complaint cases. In view of this development the methods and basis used in the work were critically reviewed in the light of the experience in the Milwaukee valuations, and certain modifications and improvements were adopted.

The methods of field work had much in common with those used in the steam railway valuations, particularly as regards the details relating to roadbed, track, structures, etc. However, the inclusion of so many electric lighting plants with these operating properties placed many features of these street railway valuations upon an identical basis with the utilities valuations.

An effort was made to have each street railway company prepare a detailed inventory and valuation of its own property. It was soon found, however, that the smaller electric lines were in much the same condition as were the smaller steam railways in 1903, in that they lacked the records and the requisite skilled staff to prepare these valuation reports. Of the 23 companies, only the Milwaukee company (operating about half the street railway mileage of the state under one management) had the necessary records and staff.

Physical Valuations Under the Public Utilities Law.

The following definition of the term "public utility" is quoted to indicate the sweeping character of this law:

The term "public utility" as used in this act shall mean and embrace every corporation, company, individual, association of individuals, their lessees, trustees or receivers appointed by any court whatsoever, and every town, village or city that now or hereafter may own, operate, manage or control any plant or equipment or any part of a plant or equipment within the state, for the conveyance of telephone messages or for the production, transmission, delivery or furnishing of heat, light, water or power either directly or indirectly to or for the public.

The law prescribes that "the commission shall value all the property of every public utility actually used and useful for the convenience of the public," and further provides that "in making such valuation the Commission may avail itself of any information in possession of the state board of assessment."

The methods now employed by the engineering staff in the valuation of the physical property of public utility plants embrace the following distinct steps or processes: (1) the preparation of a detailed descriptive inventory; (2) field examinations of the property by a trained staff; (3) determination of the "cost new" of each item; (4) estimation of the depreciation on each item of property; (5) calculation of the present value; (6) summing up the detailed valuations by groups.

REPRODUCTION COST OF THE NEW PROPERTY.—With a view to establish a definite and reliable basis for fixing costs, extensive investigations have been made relative to existing commercial conditions, with the result that a vast amount of cost data as to the purchase and installation of the various kinds of physical property embraced in the public utilities plants is now available in the confidential records of the engineering staff. This information has been gathered from many sources, one of the most important of these being the actual contracts and other records of costs kept in the offices of the various public utilities companies of the state.

The records of the companies are made available to the commission or its authorized agents by the terms of the public utilities law. These records combined with the confidential quotations and cost data of many kinds supplied through direct solicitation by manufacturers throughout the country, provide a substantial basis upon which the unit costs are kept up to date. In addition to these sources of information, the members of the staff have been able to supplement their personal records of cost data through many voluntary contributions from the professional notes of prominent engineers and by figures gathered from publications of technical societies, the columns of trade and technical journals, etc. Reference may also be made to the accumulation of valuable data included in the sworn testimony given by experts at the formal hearings of the Commission.

In order to avoid extreme variations in unit prices due to the fluctuations in market quotations and also with a view to approximate as closely as practicable the conditions which usually prevail in building up public utilities properties, it has been the practice of the staff to use average prices for a term of years rather than to apply the current quotations or unit costs prevailing at the actual date of inventory. For this purpose the average price for the five-year period immediately preceding the date of valuation has been used whenever in the judgment of the staff such rule was practicable.

DEPRECIATION OF VALUE.—In determining the allowance to be made for depreciation in value due consideration is given by the staff to the actual condition of each machine or other item of the property, taking into account the age of the device in connection with its probable ultimate efficient life, the character of the service, the standard or quality of maintenance, and such other elements as may aid in reaching a reliable judgment in the matter.

THE PRESENT VALUE.—The depreciation percentage is customarily applied against the net or service value found by deducting the scrap or residual value from the "new value," and the so-called "present value" is determined in the usual way by combining the scrap value and the depreciated service value. The treatment of scrap values has perhaps been carried somewhat beyond the degree of refinement customarily used by most engineers engaged in water-works and other like appraisal work. But it is believed that it has not been carried beyond what is consistent and proper, considering the magnitude and permanence of these Wisconsin valuations.

Other Valuation Work.

In addition to the railway and public utilities valuations covered by the foregoing description, the engineering staff (by special instructions from the Railway Commission) has made a number of valuations of "public service corporation" properties under the terms of the stock and bond issue law of 1907. These valuations have been based upon a detailed inventory, but in most instances it has not been necessary to enter into the refinements called for in the more formal valuations.

Service Inspection Work by the Engineering Staff.

In exercising the broad powers conferred upon it with respect to service regulation of railway, express, telephone, and the municipal utilities companies, it has been the uniform policy of the Wisconsin Railroad Commission to insist upon adequate service, but without undue intrusion upon the routine of actual management. The inspections of service made by the technical staff under instructions from the Commission are directed primarily to the actual results. When the results are found to be unsatisfactory the Commission frankly reports the facts to the company (and also to the complainant, if any), with such recommendations or suggestions as may seem necessary or desirable.

In the more important matters publicity is usually given through the daily press in order that the general public may be kept fully informed. Such publicity is often the only means of fixing in the public mind the responsibility for poor management or in establishing substantial justice where there have been false reports or wrong impressions as to the facts. As a general rule, the suggested improvement of service is made by the management without contest or delay. In the exceptional case, the Commission does not hesitate to use the mandatory powers conferred upon it by statute.

RAILWAY SERVICE INSPECTIONS.—The Railroad Commission has not as yet adopted the plan of employing special inspectors to engage exclusively in investigations of railway service, although such inspectors may ultimately be required with reference to certain of the more technical phases of railway operation. Provision is made by the law for the employment of the requisite expert help when the need arises. Such matters are at present investigated by the engineer personally or by special assignments from the technical staff, and reports are submitted for the information of the Commission.

PUBLIC UTILITIES SERVICE INSPECTIONS.—Among the earliest matters to claim the attention of the Railroad Commission in the execution of the public utilities law was the question of units and standards of service and tests of meters. It was early seen that the proper administration of the law would necessitate the establishment of a central laboratory equipment for the purpose of investigating the various kinds of public utilities service, with a view to the fixing of legal units and standards and also to putting the same into practice on a permanent and uniform basis throughout the state. After some preliminary discussions and conferences arrangements were made whereby the laboratory facilities of the University of Wisconsin were made available for the purposes of the Railroad Commission, with the understanding that there should be reciprocal use of the instrumental equipment to be purchased subsequently by the Commission.

The arrangements above outlined, while intended to apply to any phase of the question of units or standards which might arise under the utilities law, were most directly of use to the Commission in connection with gas and electric service, concerning which the necessity of establishing standards first arose.

With the beginning of active inspectional work in the testing of gas and electric service, it became necessary to provide special field equipments which soon took definite form as "traveling laboratories." Strong traveling cases were fitted out with straps to hold the instrument boxes in place and thick padding to protect the same in shipment. These cases are sent by express and the equipment is insured against damage in transit.

OTHER UTILITIES SERVICE INSPECTIONS.—Inspection work performed under the utilities law has also included (1) observations as to the quality of service rendered by steam heating plants and investigations as to the accuracy of metering such services; (2) tests of water pressure and of the quality of fire protection provided; (3) investigations of the accuracy of water meters; (4) tests of service rendered by telephone systems in a large metropolis, in smaller cities, and in the rural districts, etc.

Such work is being systematized as much as possible with a view to utilize the services of each staff member, in carrying on at least the simpler kind of tests (as in the case of railroad travel) while traveling or while engaged in a given locality. An important advantage accruing from such informal local contact with the utilities is found in the opportunity thus afforded to the managers of plants to ask questions and make comments which they are often unwilling to put in writing. It is one of the duties of staff members to put such questions into definite form and file the same in the "query box" at headquarters for future consideration by the staff and for the information of the Commission. Plans are on foot for the extension of this "query box" scheme.

Miscellaneous Service by the Staff.

A further line of work of a miscellaneous character demands, in the aggregate, a considerable share of time from the staff. The scope and importance of these matters is indicated below:

1. Supervision of interlocking and signaling installations.
2. Investigations of railway accidents.
3. Investigations as to the safety of track and bridges.
4. Investigations as to the protection or separation of grade crossings.
5. Reports on proposed industry tracks.
6. Examinations relative to proposed railway construction and of newly completed lines in advance of operation.
7. Investigations of street railway service.
8. Investigations in rate cases.
9. Advisory service as to operation of public utilities.

THROUGH TRAINS FROM SEATTLE TO GALVESton are announced as proposed by the Hill railway lines, the service to start on June 1, 1909. The distance between the points named is about 2,900 miles, thus making this the longest line of through-train service in the United States. Press reports state that the trains will run over the Great Northern, the Burlington, the Colorado & Southern, the Fort Worth & Denver and the Texas & Brazos Valley roads.

The Relation of Non-Pressure Processes of Wood Preservation to Pressure Processes.

By W. F. SHERFESEE.*

The development of the non-pressure processes of wood preservation (or the "open-tank" processes as they are more often but less correctly called) has come about because they fill a real need—which the pressure processes (until recently the only processes in common use) could not fill. Thirty years ago, when wood preservation was introduced into this country the pressure system, which was then the standard in the old world, was adopted and remains to-day the standard for commercial practice in both Europe and America.

When the first wood preserving plant was constructed in America the possibility of a shortage in the supply of structural timber played no part in the considerations of the owner. When the Chesapeake & Ohio Railway began to treat its wharf timbers near Norfolk in the early 80's, the conservation of natural resources had not yet become a National slogan, and thousands of Virginians were called land-poor only because they were so unfortunate as to own hundreds of acres of the finest Southern pine. It was not the first cost of the timber, but the labor of renewal, which made its preservation worth while. Hence, those timbers were first preserved which are expensive and difficult to replace, such as piling and wharf timbers, timbers for bridges and the like. The era of railroad building was still too recent to bring about heavy charges for the replacement of ties as the finest white oak, heart longleaf pine, and other naturally durable timbers offered an abundant and cheap supply. Energy and capital were expended in expansion, and not in intensive development. The financial panic of '93, and the period of railroad liquidation and reorganization, retarded a more widespread interest in the subject, so that it was not until the beginning of the present decade that wood preservation began to assume the place which it has made for itself in American forestry and engineering.

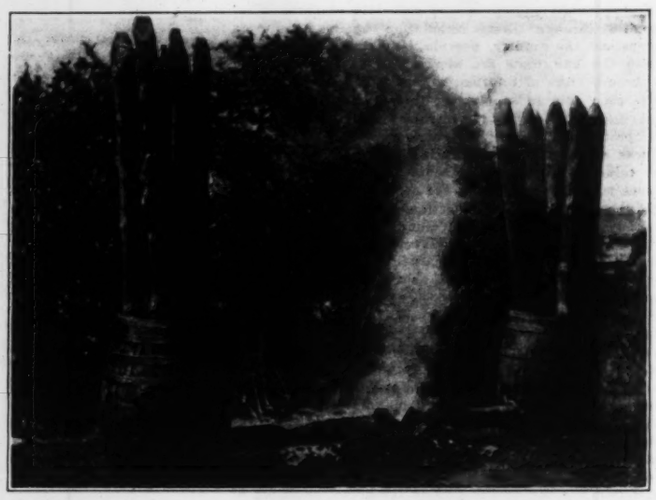

FIG. 1. A PRIMITIVE WOOD PRESERVING PLANT.

It was naturally to Europe that the pioneers of wood preservation in America looked for advice and England, more than any other country, exercised a controlling influence in the development of the American industry, up to within a few years ago. There the period of experiment, of discussion and innovation had largely passed and the industry had taken on what promised to be its final shape. Mercuric chloride, copper sulphate and other antiseptic salts had been tried and had been allowed to fall into comparative disuse. Dead oil of coal tar or creosote, injected under pressure, had become the principal resort and to a large extent had supplanted its cheaper rivals. American engineers, anxious for a reliable preservative and process without the necessity for tedious and expensive investigations, were glad to avail themselves of English experience and the pressure creosote plant has become in America, as in England, the standard and the basis for comparison in devising modifications and in the development of all new processes. There was, however, one prime difference between the practice of wood preservation in America and in Europe. Abroad the timber was generally allowed to become air dry before treatment. But to stack timber in the yard for weeks or even months before it could be used was at variance with the American spirit, and preliminary processes for artificially seasoning the timber before treatment were adopted, and, as it subsequently proved, with most indifferent success.*

In the comparatively stable form which it gradually assumed, creosoting in America consisted of three principal operations or processes; a bath of live steam, a vacuum, and the application of the preservative [illegible] pressure. The same process is used in the [illegible]n of zinc chloride. The timber, on iron tru[illegible] run into large horizontal treating cylinde[illegible] ve steam is admitted under varying pre[illegible] and for varying lengths of time. The [illegible] ge steam pressure may be considered to be [illegible]. per sq in., and four hours the average [illegible]on. The steam is then blown off and a v[illegible] drawn say for about four hours, the du[illegible]n of the steam bath. The cylinder is th[illegible]lled with the preservative, at a pressure of [illegible] 100 lbs per sq. in., until the required a[illegible] of preservative is injected. The surplu[illegible]servative is then blown back into the recei[illegible] tanks by compressed air. Assuming that [illegible] pressure period, including the filling and emp[illegible]g of the cylinders, takes about one hour and [illegible] half, we find that the entire treatment re[illegible]es nearly ten hours. In the treatment of g[illegible]n timbers of large dimensions this time is of[illegible] increased 50 to 100%. For such a process the treating plant must be equipped with adequa[illegible] pressure, vacuum and air pumps. The treating cylinders must be of steel strongly built, with doors capable of remaining sealed under strong internal pressure. Such plants are decidedly expensive to install and skilled supervision is necessary at all times.

It is now known that neither the steam bath nor the vacuum accomplish the desired results in the seasoning of the timber. Probably the only value of the bath of live steam consists in the warming of the timber with which it comes in contact, and unless applied with skill and experience it is almost certain to cause a permanent reduction of the strength. Tests have also shown that the power of the vacuum to draw out the vapors generated by the steam in the cellular structure of the wood, were based on erroneous theoretical opinions and so far from lessening the amount of moisture in the wood, the steam and vacuum baths often increase the moisture content, if the wood is even slightly seasoned to begin with.

However, it is neither the time required by such a processs described above, nor the negative or possibly injurious effects of some of the operations, that have been chiefly instrumental in developing non-pressure or open-tank processes. These often require at least as long as some of the pressure processes. Indeed in several recently constructed pressure plants, the steam and vacuum are omitted altogether and the preservative is applied directly to the air-seasoned wood in much less time than would be possible with the less complete mechanical equipment of a non-pressure plant.

The factor, to which more than to any other is due the development of the non-pressure processes, is the heavy expense involved in the purchase and installation of a pressure plant; an expense which confines such plants to large commercial companies which demand a very large and fairly constant supply of structural

FIGS. 2 AND 3. SECOND STAGE IN THE DEVELOPMENT OF AN OPEN-TANK PLANT.

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[*The history of the development of wood preserving processes is treated at greater length in an article by Mr. C. G. Crawford in Engineering News, Feb. 7, 1907. The developments in steaming processes were traced by Mr. Octave Chanute, in the issue of Jan. 31, '07. See also articles in the issues of Oct. 22 and Dec. 31, 1908. —Ed.]

timber comparatively resistant to the entrance of the preservative.

Because of the development of the non-pressure processes within the past few years, and their advocacy by the United States Forest Service for certain purposes and under certain conditions, the impression has been created that they are designed to replace the older and more firmly established pressure processes for all timbers and for all conditions. Nothing could be less correct. There is no real ground for rivalry between the two systems. Although the boundaries of their fields of usefulness may occasionally overlap, each process has a field of its own;

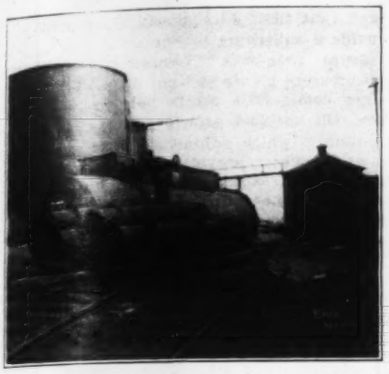

Fig. 4. Non-Pressure Preserving Plant With Horizontal Treating Cylinder.

each has a condition to meet for which the other is inadequate. The non-pressure processes are nothing more than a natural development of the old pressure system, made necessary by the need for a simpler and less expensive method for the small user or for the cheaper classes of timber. With a decreasing supply of structural timber of the better grades and an increasing price, the need became pressing for a process which would enable the farmer, with an outlay of a few cents, to make an old field pine or an aspen fence post last as long as one of locust or pitch pine; which would enable him to treat a second-growth pine pole, or perhaps only the butt of a chestnut or a dead lodgepole pine and get a longer life, at a less annual charge, than from a cedar pole; or which would enable a mine owner to treat his timbers as they are put in his tunnel or colliery, adapting the treatment to the conditions in which the timber is to be placed and the increased life desired; or which would permit a city traction company to treat its own ties and poles, especially where the freight cost from the commercial pressure plants would be prohibitive. In other words, what was needed was a process by which timber of different kinds and for use under different conditions could be treated efficiently and cheaply, in a plant inexpensive to install and simple to operate. The record of the attempts to meet this need is the history of the non-pressure processes.

It was evident at once that effort could be exerted along but three main lines. The first was in simplifying the processes for injecting the preservative into the timber. The second was in simplifying the mechanical apparatus and so lessening the cost of the plant. The third was in lessening the amounts of the more expensive preservatives without decreasing the efficiency of the treatments. It was also evident that none of these lines could be followed independently. Each is so closely related to the other that all must be considered in weighing the merits or faults of any proposed plan. Especially is the second line, the simplification of apparatus, dependent upon a corresponding advance in simplifying the process itself.

As has been seen, the old standard pressure treatments involved three processes, the bath of live steam, the vacuum, and the injection of the preservative under artificial pressure. The first step toward simplification was a careful, thorough study of the effects of these different operations. Did the steam bath really do what was expected of it? Was the moisture content of the timber really lower after steam and vacuum than before?

If these and similar questions had been answered in the affirmative, the only possible course would have been to attempt to devise means by which the results of the existing system could be equaled, or at least approached. But the work was greatly simplified as soon as American engineers admitted the correctness of views, already held by similar students abroad, that (with possible rare exceptions) the steam bath and the vacuum are inferior to air-seasoning, and often accomplish the very opposite results to those desired. Thus at one stroke it was made possible to eliminate entirely two of the most expensive and difficult processes, and to substitute therefor nothing more complicated than is involved in stacking the timber in loose piles to season in the open air.

But these operations were only preliminary processes and the crux of the problem still waited solution. The application of artificial pressure was still essential to a satisfactory impregnation. It was realized that pressure in some form is necessary; simple soaking of the timber is inadequate. It is true that in the process of kyanizing, by which the timber absorbs a solution of mercuric chloride, no pressure is used and reliance is had upon natural absorption of the solution by the timber. But such a slow process is not used from choice, and principally because of the strongly corrosive action of the solution on metals which makes it impossible to employ any of the usual forms of pressure appliances. The great length of time necessary for such an impregnation removed this process from practical consideration. This is realized when one finds that in the treatment of a bridge timber with a 12 × 12-in. section a 13-day immersion is considered necessary for a successful penetration. Without tracing the steps in the solution of this problem of pressure, it can be said that success was found in two methods. The first was in using atmospheric pressure to take the place of artificial pressure, and secondly, to a lesser extent, by employing the pressure generated by heat through the vaporization of the preservative in closed retorts.

In the so-called "open-tank process" atmospheric pressure alone is used. During the process of air-seasoning much of the moisture in the wood structure is evaporated and its place is taken by air. When the timber is ready for treatment it is immersed in a hot liquid which may or may not itself be a preservative as it serves principally as a heating medium. This warms the wood fiber and causes a rapid expansion of the air in the cells and intercellular spaces. Some of the moisture remaining in the wood is also evaporated and, together with some of the expanded air, is driven out of the timber and escapes through the liquid into the open air. This bath is continued until its effects have penetrated to a sufficient depth. The temperature of the surrounding fluid is then quickly lowered. This drop in temperature may be brought about by any of three methods. The timber may be removed from the hot liquid and quickly plunged into a bath of cold preservative; or the heat may be shut off and the timber allowed to remain in the preservative as it cools; and, best of all, the hot liquid may be run out through large pipes into underground tanks, and a preservative of a lower temperature admitted almost simultaneously. All of these methods accomplish the same results, but in different times and degrees of economy. As the temperature falls, the air in the wood structure contracts, and as some of it had been expelled during the hot bath a tendency toward a vacuum is created, which is satisfied by the entrance of the surrounding preservative. The condensation of moisture in the wood helps to increase the strength of the vacuum. The live steam, the vacuum, the heavy external pressure, have been eliminated and there is substituted nothing more complicated or expensive than air-seasoning and the heating of the preservative.

This simplification of the process for injecting the preservative immediately made possible a corresponding change in the mechanical equipment necessary for its application. Reduced to its lowest terms, all that is absolutely necessary for the application of the open-tank method is an open vat of dimensions suitable for holding the timber to be treated and so arranged that fire can be built underneath. However, such extreme simplicity is economical only in exceptional cases. Considerations of time, of labor, of fuel, of evaporation of preservative and similar questions, require a greater outlay in equipment for a less expensive operation. By steam coils for heating, instead of direct flame, the temperature can be more closely regulated, and the fuel used to the best advantage. The cooling of the preservative by radiation alone is a slow process and much time can be saved by having a second tank near at hand containing cooler preservative into which the timber can be plunged as soon as the hot bath is completed. If the timber is heavy to handle or is in large quantities, it is easier and cheaper to let it remain in the first treating tank and to provide underground wells for receiving the hot liquid, at the same time running in a charge of cooler preservative from storage tanks.

FIG. 5. PINE POLES AS REMOVED FROM A HORIZONTAL TREATING CYLINDER.

Another type of equipment is still more expensive to install, but it is the cheapest in the long run. Here the timber is loaded on iron trucks and run over the rails into a closed cylindrical treating tank, very similar in appearance and in many details of construction to the plants described above for the standard processes of creosoting under pressure. Here is found every practical mechanical device which will assist in reducing the cost of operation or in improving the efficiency of the treatment. Needless to say, such comparatively elaborate plants are adopted only where the amount of timber is comparatively large, and where even a slight reduction in the cost of treating a thousand board feet means

a very considerable saving in the course of a few months. The process is essentially the same as that of the simplest fire-heated vats, but here the term "open-tank" can be no longer applied. So far as their mechanical construction is concerned, the closed horizontal cylinder and the open tank have nothing in common. Instead of having the preservative exposed during the treatment to the open air, every effort is taken to close every vent by which the vapors can pass off into the atmosphere.

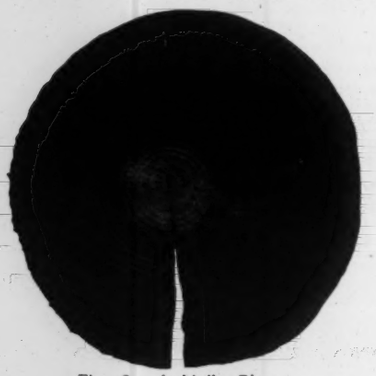

Fig. 6. Loblolly Pine.
Seasoned three months.
Two hours at 185°—105° F.
Cooled to 160° F.
Three hours at 200°—210° F.
Absorption, 6.2 lbs. per cu. ft.
Penetration, 3.5 ins.

Fig. 7. Loblolly Pine.
Seasoned two months.
Three hours at 175°—180° F.
Cooled to 140° F.
Two hours at 200°—215° F.
Absorption, 3.1 lbs. per cu. ft.
Penetration, 1.5 ins.

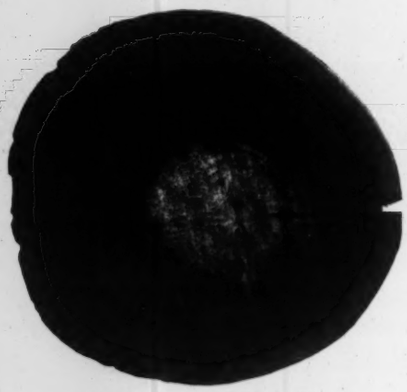

Fig. 8. Seasoned Pitch Pine.
Five hours at 230° F.
Cooled to 170°.
Absorption, 18 lbs. per cu. ft.
Penetration, 3.7 ins.

Fig. 9. Loblolly Pine.
Seasoned three months.
Two hours at 210°—215° F.
Cooled to 175° F.
Two hours at 220°—230° F.
Absorption, 3.7 lbs. per cu. ft.
Penetration, 1.5 ins.

FIGS. 6, 7, 8 AND 9. SECTIONS FROM MINE PROPS. TREATED BY NON-PRESSURE PRESERVING PROCESSES.

In an open tank the loss of the preservative by evaporation is sometimes as high as 35% of the total amount absorbed; in the non-pressure cylinder the vapors are collected, put through a condenser, and recovered for use in subsequent treatments. Despite a similarity in appearance of the cylindrical non-pressure retorts to those for the standard pressure treatments, there is a great difference in the cost of the plants. The force, vacuum and air pumps with all their connections are omitted, and the steel of the cylinders can be lighter and cheaper. The expense of installing a commercial non-pressure plant is only about a third of the cost for a pressure plant of similar capacity.

Two objections are commonly raised against non-pressure processes for commercial work on a large scale; first, the difficulty of gaging accurately the amount of preservative injected into the timber; and, second, the loss by evaporation. Without deeper discussion it can be confidently replied that the regulation of the absorption in a well conducted non-pressure plant is quite as accurate as in common practice at pressure plants and that, with the use of closed treating cylinders and condensers, the loss by evaporation is practically eliminated.

Up to this point I have endeavored to show how the adoption of the non-pressure method simplifies both the processes and the mechanical equipment. A third demand has been made and met. This was for an "empty-cell" treatment which would leave merely a coating of preservative around the cell walls instead of leaving the lumina and the intercellular spaces filled. In pressure plants this is achieved by the use of force, air and vacuum pumps. In non-pressure processes again atmospheric forces are employed and with excellent results. The efficacy of the empty-cell processes depends upon their ability to give the best treatment with the least amount of preservative—in other words to secure the deepest penetration with the least absorption. This is secured as follows. Suppose that the influence of the hot bath had extended 4 ins. in from the surface of a timber—that there had been an expansion and expulsion of the air for 4 ins. into the interior. Now, suppose the temperature is quickly lowered. In the outer zone the vacuum would first be created, and it is this zone which would be first gorged with oil. Now, if the oil is withdrawn from around the timber before the penetration has reached more than 1 in. into the interior of the stick, there is left an inner space of 3 ins. in which a vacuum is formed by the contraction of the air; and to destroy this vacuum, the surplus oil is drawn in from the outer saturated zone, leaving merely the desired film around the cell walls. A penetration of 4 ins., therefore, is secured with a saturate absorption of but one.

As yet little is known of the possibilities of utilizing the pressure generated by the evaporization of the preservatives in closed retorts, but already surprisingly suggestive results have been achieved. It is probable that "semi-pressure" plants will be widely developed—i. e., plants which are heavy enough to withstand moderate pressures, say 40 or 50 lbs. per sq. in., and yet not so heavy as largely to incr their cost. The pressure can be obtained eith vaporiza- tion or by the same pump used conveying the preservative from the underg wells to the storage tanks. Several prob must be solved before a rapid advance ca expected; but already one such low-pressu ant is in course of construction, and others projected. The opportunity these will afford fo estigation may confidently be expected to b ductive of practical results.

It is not difficult to forecast the place in the industry of wood preservatio which the non-pressure processes are to hold. misconception will be cleared away if rem- bered that their development is n tended to provide a substitute for, or to com with, the pressure processes. Generally s king, the non-pressure plants will not draw w from the larger commercial plants but, on contrary they will be used principally for treatment of timber which otherwise would main un- treated. They provide a cheap efficien method for treating certain of the re porous classes of timber in isolated locati and they are for the small users to whom the expense of the commercial pressure plants is prohibitive.

The writer has appended a few illustrations which seem interesting as typical installations. Fig. 1 shows what is perhaps the most primitive apparatus. The flame is applied directly to the connecting pipe which heats the preservative in the barrels by convection. Fig. 2 shows the first refinement of the open-tank processes. The timber is heated in the vertical cylinders and cooled in the rectangular sheet-iron tanks. The portable boiler and engine is used merely to supply steam for the hot bath. Figs. 6 to 9 show 12-in. sections cut from the middle of 10-ft. loblolly pine mine props after treatment by non-pressure processes. The checking shown occurred after the sections were cut and would not have taken place in intact timber.

Underpinning a Building with a Concrete Girder 105 Ft. Long.

A massive reinforced-concrete girder 105 ft. long was completed recently at Evansville, Ind., to form the foundation of a new wall for the west end of the water-works pumping station. It spans the filling of an old trench, the settlement of which (after a break in the intake pipes) had caused the failure of this wall of the building. The girder is 3 ft. 6 ins. wide and 14 ft. 6 ins. deep for a length of 55 ft. spanning the trench, and has footings 20 × 25 ft. The method of repair was designed by Messrs. John W. Alvord and Charles B. Burdick, of Chicago, who are the consulting engineers for the new filtration plant now being built at Evansville. The detail plans for the girder were prepared by E.

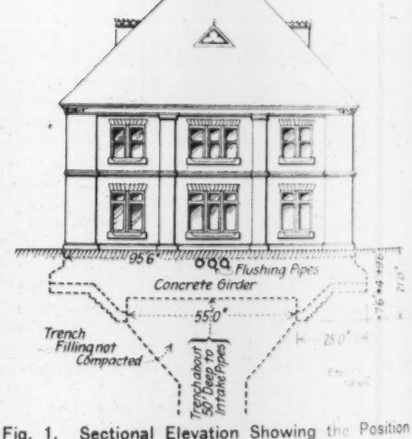

Fig. 1. Sectional Elevation Showing the Position of the 105-Ft. Concrete Girder Used For Underpinning the End Wall of the Pumping Station at Evansville, Ind.

C. & R. M. Strickland, of Chicago. The work was completed in December, 1908. It was done by day labor under the direction of Mr. John W. Peck, Superintendent of Water-Works. Mr.

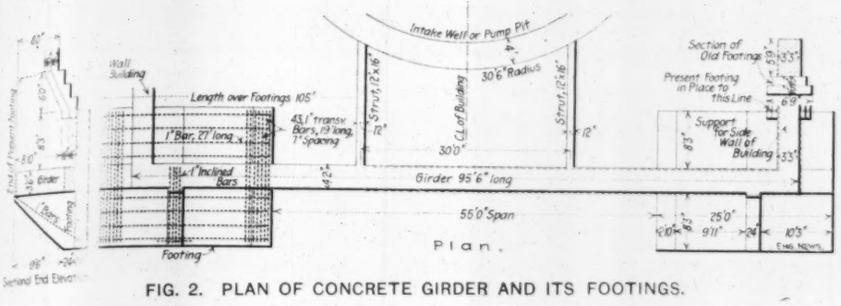

FIG. 2. PLAN OF CONCRETE GIRDER AND ITS FOOTINGS.

C. C. Culp was the foreman in charge of the work, and he has furnished us with information as to the methods employed in building the girder.

The pumping station is a brick structure, with stone trimmings and a steeply-pitched steel roof covered with slate. It was built in 1900. It is about 95 × 165 ft., with walls 45 ft. high, and contains an engine room and boiler room. In the middle of the engine room is the pump pit, 53 ft. inside diameter, with its floor 58 ft. below the surface. As originally constructed the three 30-in. intake pipes were about 48 ft. below the surface, being laid in a deep trench.

A break in the intake pipes occurred in December, 1903, at a point just outside the pumping station. The resulting flow of the sand and consequent settlement of the ground endangered the west end of the building, and after unsuccessful attempts to reach and repair the break it became necessary to shut down the pumping plant. A temporary water-supply was furnished by pumps installed on the bank of the river, while a new intake connection was made, entering the pump pit about 20 ft. above the floor of the pit. This intake was in use until 1906, when permanent repairs were commenced. The old trench was opened, and the pipes were removed. Piles were driven in the bottom of the trench and covered with a timber grillage embedded in concrete. Upon this the three 30-in. intake pipes were relaid. The lower part of the trench was sheeted, and the upper part was sloped as shown by the dotted lines in Fig. 1. The trench was then refilled to the surface. The three 20-in. pipes which pass through holes in the center of the concrete girder are connected to the intake pipes inside the pump pit, and are for the purpose of flushing out these latter pipes.

Shortly after the accident occurred, the end wall of the building was taken down, and a temporary timber wall built about 10 ft. inside the building. Heavy inclined posts extended from footings at the base of this wall to support the overhanging ends of the roof trusses. This construction was continued in use until 1908, when the reconstruction of the wall was taken up by the engineers, as noted above. The break in the pipes and the repairs of the pumping station were described in our issue of March 17, 1904.

The cutting edge of the pump-pit caisson rests on a bed of gravel about 72 ft. below the surface (22 ft. below the low water line). Above this is a bed of fine sand 18 to 20 ft. thick, covered with a bed of silt or river deposit 24 to 27 ft. thick, and containing three layers of decayed vegetable matter from 4 to 5 ins. thick. The silt formed the original ground surface, but was covered with an earth fill 27 to 28 ft. thick, which was placed in 4-in. layers and well rolled with a 16-ton roller. This material is quite compact, and carries the foundations of the building and the smokestack. The heavy pumping machinery, however, rests upon the wall of the pump pit, and this has shown no settlement. The building has settled considerably, from 3¼ ins. at the northeast corner to 17½ ins. at the southwest corner, but the walls have not been injured, owing (it is thought) to the steel bands embedded in the brickwork. The settlement is considered to be due to the compacting of the silt and the layers of vegetable matter, rather than to the compacting of the filled material on the surface. The settlement occurred within a short time after the construction of the building, and no further movement has been noted. It was considered, therefore, that the surface fill, where not disturbed by the trench for the repairs to the intake, would form a good foundation for the repairs to the building. In view of the running sand it was thought inadvisable to seek a deep foundation.

The plan suggested, and now executed, was to build a heavy reinforced-concrete girder under the end of the building; its ends rest on large footings in the solid fill, and it has a clear span of 55 ft. over the unstable material with which the trench for the intake pipe was filled. The footings are so designed as to limit the bearing pressure upon the soil to about 1,600 lbs. per sq. ft., which is about 20% less than that upon the present footings of the other parts of the building.

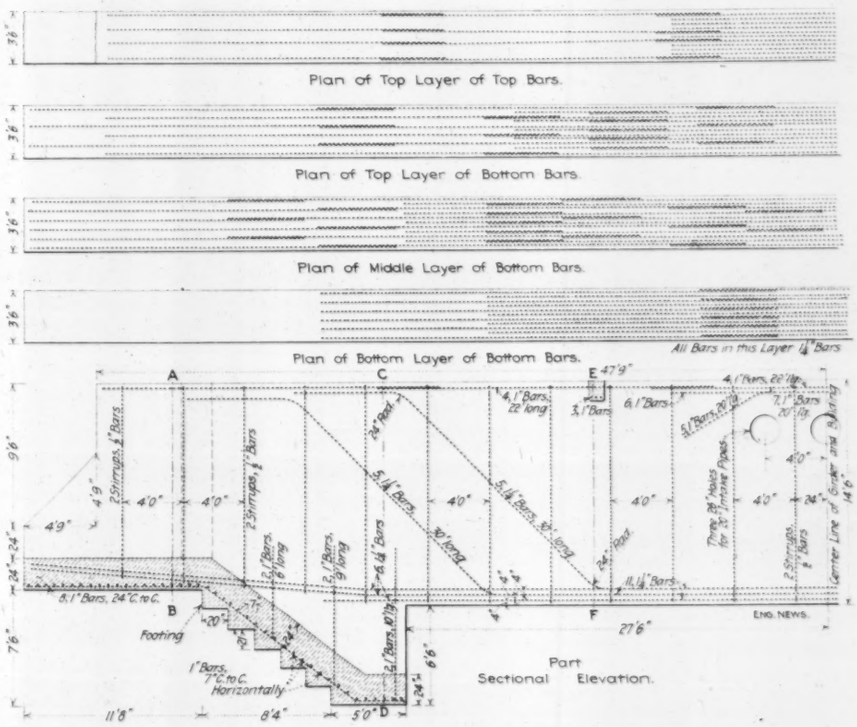
Plan of Top Layer of Top Bars.
Plan of Top Layer of Bottom Bars.
Plan of Middle Layer of Bottom Bars.
Plan of Bottom Layer of Bottom Bars.
All Bars in this Layer 1¼" Bars
Footing
Part Sectional Elevation.
Eng. News

FIG. 4. STEEL REINFORCEMENT IN THE 105-FT. CONCRETE GIRDER; EVANSVILLE, IND.

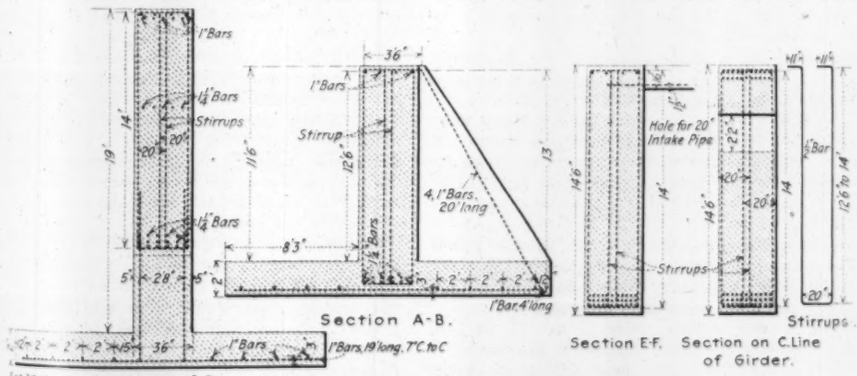

FIG. 3. CROSS SECTIONS OF 105-FT. CONCRETE GIRDER.

The girder is 95 ft. 6 ins. long, or 105 ft. over the footings, with a clear span of 55 ft. between the footings. It has a uniform thickness of 3 ft. 6 ins., with a depth of 14 ft. 6 ins. in the main portion and increasing to 19 ft. over the deepest part of the footings. Each footing is 20 ft. 6 ins. × 25 ft., and has a knee brace against the outside of the girder. On the inner side of the girder, at each end, is a return wall supporting the end of the side wall of the building. Two concrete struts 12 × 16 ins. extend from the top of the girder to the wall of the pump pit. The general arrangement of the girder is shown in Figs. 1 and 2, while the details of its design and reinforcement are shown in Figs. 3 and 4. In its upper part are three 26-in. holes for the 20-in. flushing pipes.

The concrete is a 1:2:4 mixture, made with broken stone ranging in size from 2 ins. downward. The size of the girder is so great, and the reinforcing bars are so large, that there was plenty of opportunity for the concrete to thoroughly surround all parts of the reinforcement. The reinforcement consists of cold-twisted steel

bars and steel stirrups, the bars being mainly 1 in. and 1¼ ins. square. The bars were held at the proper position by means of wires and wooden cleats, the latter being removed as the concrete reached them. The form was built on the ground. It was left in place for 30 days after the completion of the girder, and during this time the concrete was kept continuously moist.

The concrete for the footings was all mixed by hand on mixing boards placed near the work, and was put in place partly by the use of shovels and partly by wheelbarrows. The construction of this part of the work occupied ten days. After the footings had been completed to the level of the bottom of the girder, a concrete mixer was used. This was of ¾-cu. yd. capacity, but the batches used on this work were of ⅓-cu. yd. only. The concrete was of a wet or "sloppy" consistency. It was tamped around all the steel reinforcement by means of small wooden rammers and spades. Where there was no reinforcement, the concrete was not tamped but was only spaded at the face of the form and leveled as it was deposited. The concrete was handled in wheelbarrows, and dumped into a movable sheet iron hopper which delivered it at the top of the previous layer. The quantity of concrete deposited daily was from 10 to 12 cu. yds. with hand mixing, and from 20 to 25 cu. yds. with machine mixing.

The girder was not built continuously, but its construction occupied 20 days with a nine-hour shift each day. The unfinished work was not protected in any way, as the weather was pleasant and no rain fell during the time. The concrete was deposited uniformly over the full length of the girder in layers 12 ins. thick, and on finishing work each day the surface of the concrete was left as rough as possible. Before depositing concrete the next morning, the surface was covered with a very thick grout of cement and sand, 1 to 1. Then the first layer of concrete was deposited and well tamped.

The old brick wall was 30 ins. thick for its full height of 45 ft., and was ornamented with heavy cut stone trimmings and cornice. The weight of wall and roof above the water table was about 6½ tons per lin. ft., or a total of about 620 tons for the west wall. This construction was unnecessarily heavy. The new wall is 12 ins. thick, with pilasters 30 ins. thick to carry the roof trusses. Large window openings are used to further reduce the weight. The stone cornice is replaced with a cornice of galvanized iron matching the stone cornice on the other sides of the building. (See Fig. 1.) In this way the weight of the wall has been reduced to about 3½ tons per foot. The weight of the girder is also 3½ tons per foot, making the total load supported 7 tons per foot.

The total cost of the work on the girder and the wall was about $16,270.

INVITATIONS TO A WORLD CONSERVATION CONgress to meet at The Hague in September, 1909, have been sent to 45 nations, who are requested to send representatives to the Congress.

The Ohio River Dam and Lock No. 37, Near Cincinnati, O.

One of the most important works now under construction for the improvement of the Ohio River for purposes of navigation is the dam situated a few miles below Cincinnati. This is a movable dam, and as shown in the general plan and profile, Fig. 1, it consists essentially of three parts: (1) the Chanoine movable wicket dam, 900 ft. long, for the navigable pass or channel; (2) three 80-ft. bear-trap dams on the Kentucky side; (3) a lock 100 × 600 ft. on the Ohio side. It has the distinction of being the longest movable dam in the world. Heretofore, a length of about 700 ft. has been considered the maximum that could be operated reliably, but in this case the movable portion will have a length of 900 ft.

The improvement of the Ohio River for navigation was described at some length in our issue of Oct. 8, and it was shown that the present scheme of improvement provides for a series of 54 dams and locks to maintain a minimum depth of 9 ft. at low water. The Ohio River traffic is peculiar in that it consists mainly of fleets of barges. Each fleet is composed of a number of barges lashed together side by side and end to end to form a floating mass that is handled by a single steamer or tow boat. During a considerable part of the year the river is available for open navigation, and the construction of fixed dams would involve serious trouble and delay in passing the fleets through the locks, while it would destroy the extremely low cost of transportation which has been obtained by this system of handling the traffic.

The plan adopted therefore (and originally suggested some 35 years ago by Major Wm. E. Merrill, Engineer Corps, U. S. A.) was to use movable dams, which could be lowered during high-water stages so as to lie flat at the bottom of the river and offer no obstruction to navigation. At low water, the dams could be raised so as to establish "pools" for slackwater navigation, the locks being used then to pass vessels from one pool to another.

At the present time there are six dams completed, while work is in progress on others. In each case there is a movable dam of the Chanoine wicket type for the navigable pass or channel, a weir of the wicket or bear-trap type for regulating the level of the upper pool, and a masonry lock for use when the dam is raised. The locks are made unusually large (110 × 600 ft.) in order to handle rapidly and economically the barge fleets mentioned above.

The largest of these dams is No. 37, situated opposite the town of Fernbank, O., about 12 miles below Cincinnati (and 481 miles below Pittsburg). It is about 7½ miles above the mouth of the Big Miami River. The construction of this dam will form a pool extending about 23 miles up the Ohio River, and will greatly increase the importance of Cincinnati as a river port. Instead of an ever-varying water level, and interference with traffic by low water, there will be a slackwater pool with a [illegible]mum water level sufficient for navigation at [illegible]times. The surface of the upper pool will be [illegible] ft. above sea level, or about 11 ft. on the [illegible]gage. The low water elevation at the dam is [illegible] ft.

In view of the great variation [illegible] river level, the swift current, the amount [illegible]ating material (brush and ice), the amou[illegible] silt held in suspension, and the great v[illegible] of water passing at flood stages, it is imp[illegible]t that the dam should interfere as little as p[illegible]le with the natural conditions of the river. [illegible] movable dam meets this requirement, as [illegible]as the requirement for free navigation at [illegible] water.

The maximum range of water le[illegible]n the Ohio River at Cincinnati is 69 ft. be[illegible]n the extremes of high and low water. [illegible]e average annual range is 47.7 ft. At flo[illegible] stages, the current attains a velocity of abou[illegible] miles an hour. The maximum and minimum [illegible]ges of the river at Cincinnati for a series [illegible] years are given in the accompanying tabl[illegible] Anything above 50 ft. (the "danger point") is [illegible]onsidered a flood. The datum or zero point o[illegible] the gage is the low-water stage of 1895, and [illegible] 430.06 ft. above sea level.

Year.	High Water.	Low Water.
1832 (flood)	64.2	...
1847 (flood)	63.6	...
1860-1870	42.5 to 57.3	3.0 to 8.7
1870-1880	40.5 to 55.3	2.3 to 6.2
1880-1890	38.2 to 71.6	1.9 to 6.1
1890-1900	35.6 to 61.4	2.3 to 5.5
1901	59.7	4.2
1903	53.1	4.5
1905	48.2	6.5
1906	50.2	7.1
1907	65.2	7.0

At the site of the dam, the river has a width of 1,270 ft. at low water, with a greatest depth of about 8 ft. at low water. This site was selected after extensive investigation by borings at various sites, and is specially favorable in having a solid rock foundation which approaches very close to the surface. There is only one narrow place where the depth was such (15 ft.) as to require piling. The formation consists of beds of limestone with intervening layers of shale or soapstone. Its surface is about 12.9 ft. below low water at the dam, and 9.7 ft. at the lock. Under the upper end of the lock the thickness of the rock is about 17 ft. All the foundation masonry is of concrete, with foundations carried down to the solid rock through from 1 ft. to 15 ft. of gravel and sand forming the bed of the river.

Buildings for the power plant and the lock attendants will be located on the Ohio side, and will be built on filled ground raising them above the highest flood stage. The grounds will be graded and covered with turf, but the lower parts of the slopes will be protected by an inclined retaining wall of concrete. At the lock chamber, a space 120 ft. wide (extending to the toe of the slope) will be paved with brick, as shown in Fig. 2. Concrete paving will also be laid on the slope of the backfilling extending from the Kentucky abutment to the top of the natural bank. All this paving and protective work is to prevent the river from cutting around

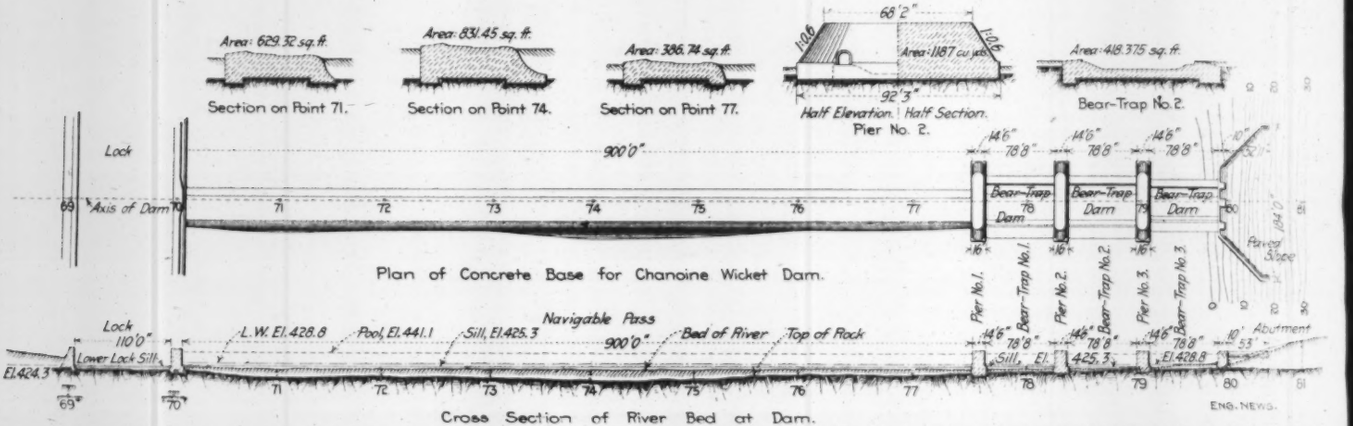

FIG. 1. PLAN AND PROFILE OF THE OHIO RIVER DAM (NO. 37), NEAR CINCINNATI, O. (SHOWING THE POSITIONS OF THE MOVABLE WICKET DAM, THE THREE BEARTRAP DAMS, AND THE LOCK).

the dam or lock during floods when the entire structure may be covered with water.

Compressed air will be used to operate the bear-trap dams, the lock gates, and the filling and emptying valves of the lock. An 8-in. wrought iron main is carried from the power-house to a well in the land wall of the lock, and thence to an 8-in. pipe embedded in the concrete

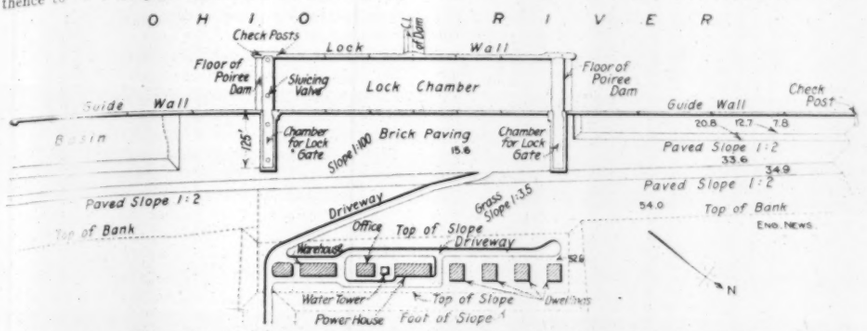

FIG. 2. PLAN OF LOCK AT OHIO RIVER DAM NO. 37. (SHOWING THE GUIDE WALLS AND THE BASIN FOR REPAIRING BARGES, ETC.).

base of the lock and dam. Wherever a pipe emerges from the concrete a heavy brass sleeve connection is used, having its lower end embedded in the concrete. This provides for pipe connections in the event of the embedded iron pipe corroding and leaving only a hole in the concrete. All pipes are tested to 200 lbs. pressure just before the concrete is laid over them.

There will be seven buildings, as shown in Fig. 2. They include the power-house, office, warehouse, and four dwellings. In order to raise them above the flood level of the river, an embankment has been built about 9 ft. above the natural surface of the ground. The concrete foundations were extended to a solid footing in the natural soil, the embankment being afterwards filled in around them. Above the grade line, the buildings will be of light buff brick, with terra-cotta trimmings and tile roofs. The power-house and warehouse will have steel roof trusses and floors of reinforced-concrete. The power-house will contain the boilers, air compressing plant, air receivers, electric light plant, pumps and repair shop, etc. There will be a sewer system and a water supply system, the water being taken from wells and pumped to an elevated tank.

The work is under the direction of Lieut. Col. Wm. T. Rossell, Engineer Corps, U. S. Army, who is in charge of the general improvement of the Ohio River. Mr. R. R. Jones is Chief Assistant Engineer. Mr. E. W. Buell is Junior Engineer and Principal Inspector in resident charge of the work. The estimated cost is $1,150,000. The dam was approved in 1902 by Congress, which has appropriated $1,150,000 for its construction. The work was commenced in 1905, and is expected to be completed in 1910.

The contract was awarded in 1904 to the Sheridan-Kirk Contract Co., of Cincinnati. This contract includes the main dam and lock (with both fixed and movable parts), the grading, road making and paving, sewers, and foundations of buildings. It does not include the steam and compressed air machinery, electric light plant, water supply and buildings. The government supplies the Portland cement. The contract aggregated nearly $800,000. Under the terms of the contract the construction was to be completed in 350 fair working days from the date of commencement. Allowance is made for a total suspension of work from Dec. 1 to June 1. Also for all other days when work is stopped by ice, freshets, etc., and for the removal and reinstallation of the construction plant.

Wicket Dam for the Navigable Pass.

The length of this main portion of the dam is 900 ft., between the lock wall on the Ohio side, and the pier of the first bear-trap dam on the Kentucky side. This is the greatest length of movable dam yet built, the longest existing dam of this type being 700 ft. (Ohio River dam No. 2). The concrete base is about 45 ft. wide, and from 10 ft. to 15 ft. thick. Its surface extends but little above the bed of the river, and its sill elevation is 3.5 ft. below low-water level (Fig. 1).

As already noted, it is of the Chanoine type, consisting of a series of panels or wickets, the tops of which incline downstream 20° from a vertical plane when the dam is raised. Each wicket is pivoted horizontally at mid-height to a steel frame or "horse" whose lower end is pivoted in bearings or "horse-boxes" on the concrete base of the dam. To the upper end of the "horse" is attached the end of a wrought-iron bar or "prop" whose foot slides in a cast iron grooved guide or "hurter" embedded in the concrete. The general arrangement is shown in Fig. 3, while the details of the wickets and other parts are shown in Fig. 4.

Each wicket is 16 ft. 11 ins. long, and 3 ft. 9 ins. wide, composed of three 15-in. oak timbers, 12 ins. thick at the lower end and 8 ins. at the upper end. They are fitted together with pine tongues and secured by through bolts. At the back of each wicket are two journal bearings near the middle and two oak cushion blocks near the top. Near the lower end of the face is embedded an iron breech weight to sink this end of the wicket when closing the dam. Handle irons in sockets at top and bottom provide attachments for the hooks of chains or poles used to raise and lower the dam. When raised, a shoe plate at the back of the wicket bears against the chamfered upstream face of an oak sill capped with wrought iron plates. When lowered, the wicket lies horizontally behind the sill, with its cushion blocks resting on the concrete base.

There are 225 of these wickets. A 3-in. space is left between each pair of wickets, in order to allow free movement. These openings can be closed when necessary by inserting needles of 3-in. plank.

When the dam is raised, the foot of each prop rests in a step or seat formed in the channel of its hurter. To lower the dam, a derrick boat is floated close to the upstream side, and a man with a pole or boat hook attaches a wire cable to a handle in the top of the wicket. This cable is hauled in by a hoisting engine so as to pull the wicket slightly forward; the foot of the prop also moves forward, and is guided sideways by a groove so that it slides into the unobstructed return channel of the hurter. The cable being detached, the water pressure forces the wicket down, the prop sliding back in the hurter, and the wicket assuming a horizontal position. The water beneath the wicket prevents any shock or violent motion, and the wicket settles quietly to rest on the concrete base. In case of any failure to act properly, the foot of the prop can be lifted out of the hurter by means of a hook engaged with a notch in the underside of the prop.

To raise the dam, the derrick boat grapples for the handle in the head of the wicket, and then raises it. This causes the foot of the prop to slide forward in a groove of the hurter until it drops into the recess or pocket which forms the supporting step. When raised, the tops of the wickets are 12.3 ft. above low water level. When lowered, they are a few inches lower than the top of the sill.

The wickets in erected position (within the cofferdam) at Dam No. 4 (Ohio River) are shown

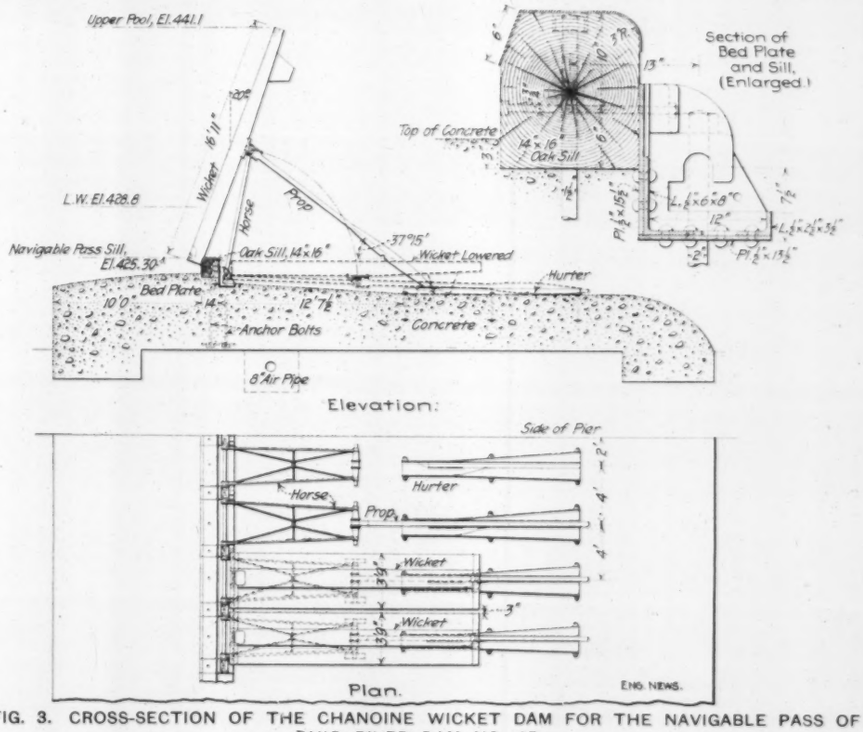

FIG. 3. CROSS-SECTION OF THE CHANOINE WICKET DAM FOR THE NAVIGABLE PASS OF OHIO RIVER DAM NO. 37.

in Fig. 5. The method of operating a wicket dam is shown in Fig. 6, which represents work at Dam No. 1. For these and the other photographs reproduced we are indebted to Mr. J. W. Arras, U. S. Assistant Engineer, Pittsburg, who used them in illustrating a paper on "The Ohio River" read before the Engineers' Society of Western Pennsylvania in May, 1908.

Bear-Trap Dams.

The three bear-trap dams adjacent to the wicket dam of the navigable pass are for the purpose of regulating the level of the upper pool

when the dam is raised. Each one is 80 ft. long. In these dams the buoyancy of closed chambers is employed to assist the raising and lowering. In many dams of this type, compressed air is admitted beneath the leaves in order to raise them, but in the bear-traps of Dam No. 37 the air is admitted to the interior of the downstream leaf, which is a steel box or caisson. Each bear-trap consists of two leaves pivoted at the bottom, and the upper edge of the upstream leaf rests against (and slides upon) the face of the downstream leaf. When raised, the two leaves and the concrete floor form a triangle. The base width is 47 ft. 2 ins. c. to c. of the hinge pins of the two leaves. The maximum height is 16 ft. 6 ins.

The upstream leaf is 25 ft. wide. It has a steel frame consisting of 15-in. I-beams 5 ft. apart, with longitudinal 61-in. channels framed between to carry the white-oak timbers which form the face or sheathing.

The downstream leaf is a hollow box, of steel construction throughout. It has plate girders 32 ft. 2 ins. long, spaced 5 ft. apart, and connected by rows of lateral bracing. At each end also (that is, at the top and bottom of the leaf), they are connected by a longitudinal plate girder; this gives the necessary rigidity, and prevents any warping or distortion of the surface during operation. The framing is covered with a top and bottom skin plating of $\frac{3}{16}$-in. steel plates, thus forming a watertight cellular structure. Manholes and limber holes are provided in the webs of the inner girders, to connect the several compartments. The I-beams of the upstream leaf and the plate girders of the downstream leaf are pivoted in pedestals anchored to the concrete floor. Fig. 7 shows the details of construction, and Fig. 8 shows the building of the downstream leaf of the bear-trap at Dam No. 3.

Both leaves have end packing to form a watertight joint with the concrete pier. That of the downstream leaf is a bent steel plate, attached to hangers suspended from the frame of the side of the leaf. Attached to the hangers are counterweights which tend to swing the plate outward, and thus hold it against the face of the pier. This is shown in Fig. 9. For the upstream leaf, the packing is a sliding timber at the back of the face. This is held against the face of the pier by coiled springs (Fig. 7).

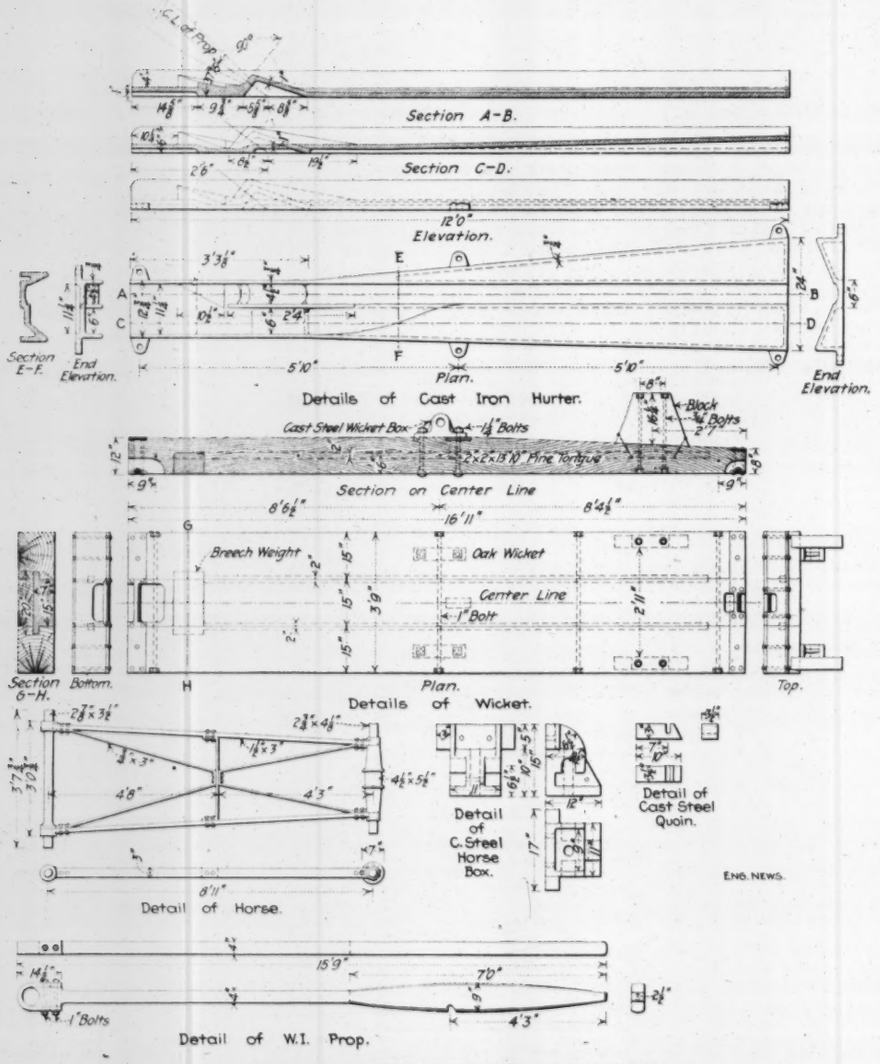

FIG. 4. DETAILS OF THE CHANOINE WICKET DAM.

When the dam is lowered, the downstream leaf lies horizontally in a chamber in the floor, with the upstream leaf resting upon it. The horizontal face of the latter is then level with an oak sill placed in front of its hinges. The downstream leaf is then full of water. To raise the dam, air at about 5 lbs. pressure is admitted to the interior of this leaf by means of two 4-in. pipes, which enter at points in line with the axis of the hinges and are extended nearly to the upper end of the leaf. These pipes have swivel and telescopic joints to allow for the movements of the dam, as shown in Fig. 9.

The air being delivered at the upper edge of the leaf tends to cause it to rise, the buoyancy increasing as the air pressure forces the water out through openings provided at the lower or hinged end of the leaf. At the same time water under pressure due to the head above the dam is admitted to the chamber beneath the leaves and raises them from their seats. In this way the raising of both leaves is effected through the displacement of the lower leaf without special regard to the head of water. Stops prevent the leaves from rising so high as to throw them out of contact. To lower the dam the air pressure in the downstream leaf is released, and the water in the floor chamber is also released. Water being admitted to this leaf weights it so as to force it downwards, pushing the other leaf down with it.

The compressed air is conveyed from the power-house (on the Ohio side) to the bear-traps by an 8-in. wrought iron main embedded in the concrete floor of the dam. This has 4-in. branches at each pier and at the abutment, leading to the hand-operated valves by which the movements of the bear-traps are controlled. In each pier and in the shore abutment is a tunnel parallel with the river; this has a lateral opening to the river above the dam and another below the dam. It has also five filling and discharge conduits connecting with the chamber in the floor of the bear-trap. In this tunnel are two butterfly valves. When the dam is to be raised, the valve on the downstream side of the dam is closed, and that on the upstream side is opened, thus admitting water beneath the leaves of the dam. When the dam is to be lowered, the upstream valve is closed, and the lower valve opened, thus draining off the water from the chamber. The air valves and water valves are operated by hand gear on each pier and on the abutment.

Lock.

The lock is 110 ft. wide in the clear, with a length of 600 ft. between the gates. These dimensions have been adopted for all the Ohio River locks, with a view to the rapid and convenient handling of the large tows or fleets of coal barges, which are a feature of Ohio River navigation, as already noted. The outer or river wall of the lock is 690 ft. long. On the shore side, there is a guide wall extending about 600 ft. above and below the lock, making a total length of 1,851 ft. The walls have check posts or mooring posts for convenience in handling vessels approaching, entering and leaving the lock. At each end of the river wall is a signal tower for lights to indicate the location of the lock and to show whether the dam is raised or lowered. All the walls are stepped on the rear side, except that at the dam the back of the river wall is carried up vertically in order to make a joint with the end wicket of the movable dam. A plan of the lock is shown in Fig. 2, and cross sections of its walls are shown in Fig. 10.

Behind the guide wall on the upstream side of the lock is a basin 450 × 127 ft. (Fig. 2). This will provide accommodation for repair work on barges, etc., and at some future time it may be converted into a dry dock by fitting it with a gate. The land side and lower end of the basin are earth slopes paved with concrete.

The lock is filled and emptied by means of culverts in the river wall, there being 16 filling culverts above the dam and 16 discharge culverts below the dam. These are 12 ft. apart, and extend through the wall, from the lock chamber to the river. Each culvert is 4½ ft. diameter, and is fitted with a balanced valve turning on a vertical axis. A shaft extends from the valve to the top of the wall, and each shaft is operated by a small compressed air engine or "jack." These 16 jacks are operated simultaneously.

At each end of the lock, provision is made for a needle dam to close the chamber in case of any accident to the gates. These dams are of the Poiree type (located as shown in Fig. 2). A row of steel bents is placed across the chamber, the bents being pivoted at their feet so as to swing laterally. These bents lie normally in a recess across the concrete floor. To close the opening, the bents are raised by chains, and are connected by rigid members at the top. Timber

needles are then set in place by hand from a bridge laid upon the bents, the lower end of each needle resting against a sill and the upper end resting against the bridge. This is shown in Fig. 11.

At high water, the lock chamber and its gate recesses become filled to a considerable depth with fine silt. This has to be removed by sluicing or hydraulic excavation when the water goes down. For clearing the upper end of the lock, a 4-ft. sluicing culvert is formed beneath it and the gate recess, and opening into the river. This has four inlet openings, in the floor of the recess and lock, through which the mud is sluiced into the culvert. The openings are closed by horizontal butterfly valves operated by chains leading to the wall of the lock.

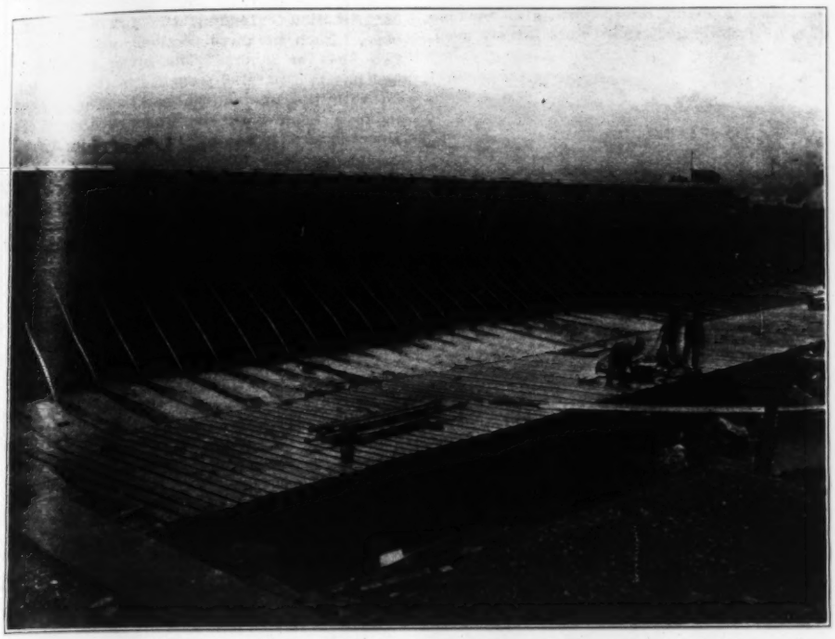

FIG. 5. CHANOINE WICKETS IN RAISED POSITION (WITHIN COFFERDAM) AT DAM NO. 4, OHIO RIVER.

Rolling Lock Gates.

At each end of the lock is a gate of the rolling type, which runs back into a recess at right angles to the lock chamber when the lock is opened. This gate arrangement (originally devised by Major Merrill, U. S. A.) has been adopted for all the Ohio River locks. The gates are built of structural steel, with watertight faces of planking. The upper gate weighs about 116 tons, and the lower gate 140 tons.

Each gate is about 118 ft. long, 19 ft. high and 9 ft. wide. The construction of the lower gate is shown in Fig. 12. It consists of a pair of trusses, with box-girder top and bottom chords which are made very wide in order to give great horizontal stiffness to resist the water pressure. The panel length is 12 ft. 8 ins. The posts of the upstream truss are composed of pairs of 10-in. channels, while the others are built up of angles and lacing bars. There are transverse struts at top and bottom, and horizontal and vertical bracing is fitted between the posts.

On the downstream side are vertical channels to support the horizontal timbers which form the face. These timbers are of white oak, painted with carbolineum (imported from Germany) as a preservative. This timber sheathing is on the downstream face only of each gate. In the bottom of this face are 18 balanced rectangular butterfly valves 3 × 4 ft., for filling or emptying the lock in the event of any accident interfering with the operation of the filling and discharge culverts and valves in the river wall of the lock. Each valve in the gate is operated by a rod connected to a lever at the top of the gate (Fig. 11).

Each gate is carried on 12 pairs of 33-in. car wheels, which are outside the face of the gate. These have axles 7⅛ ins. diameter, with journals 7 × 8 ins. in phosphor-bronze boxes. The wheels run on two sills, with a gage of 11 ft. 6 ins. (Fig. 10). Each sill is composed of a heavy 12-in. channel riveted against steel pedestals anchored to concrete foundations. On the top of the channel and the pedestals is a 1¼-in. track plate 12 ins. wide.

The gate has swing-link connections to its axles, as shown in Fig. 13. When subjected to water pressure on its face, the gate is forced about 1⅛ ins. backward, so as to take a bearing against the seats in the walls and floor. The bottom joint is made watertight by a packing timber on the face of the gate, which is pressed against the steel channel of the wheel track. The end joints are sealed by vertical iron pipes which are pivoted eccentrically and are held against the seats by the water pressure. When the pressure on the gate is released, its weight returns it to the vertical position, swinging clear of its bearings against the sill and walls. When the lock is closed, the head of the gate rests in a recess in the river wall of the lock.

The gate is moved by means of a chain which is wound upon a drum across the mouth of the gate recess, and has its ends attached to opposite ends of the gate. The drum is 20 ins. diameter and 11 ft. long, and is operated by gearing from a two-cylinder engine driven by compressed air. If the chain was rigidly attached to the gate, a sudden jerk in starting would be liable to break the chain or its attachment. For this reason a tug lever is used. This hangs vertically from a pin in the gate framing, and has the operating chain attached to its lower end. It is held back by heavy springs which receive the pull of the chain and take up any shock or jerk. Fig. 14 shows the operating drum and chain of the rolling gate at Dam No. 6. The gate recess is roofed with cast-iron plates laid on transverse I-beams. The floor has a slope of 1% towards the lock.

Construction Plants and Methods.

The construction work has been done, of course, under the protection of cofferdams. The lock and its guide walls were first undertaken, and are practically completed. A space about 650 × 240 ft. is now laid dry for the first portion of the foundation of the wicket dam (at the Ohio end).

The cofferdam as built consists of two rows of round piles about 22 ft. apart, the piles in each row being 6 ft. apart. On the inner side of each row are lines of waling timbers, against which is driven a single line of tongued-and-grooved sheet piling. Tie-rods are placed across the top of the enclosed space, being secured by nuts on the outside of the piles. The 20-ft. space between the two lines of sheeting was filled with gravel dredged from the river, the material containing a considerable amount of large stone.

FIG. 6. DERRICK BOAT OPERATING MOVABLE DAM NO. 4.

This was deposited by dipper dredges and derrick buckets, being spread and leveled by men inside the cofferdam. The cofferdam was finally covered with a plank floor.

This work has proved to be very watertight, even under a considerable head of water, and very little pumping is required to drain the enclosed space. Ordinarily, any small leaks are soon choked by the silt contained in the water. During the recent remarkably low stage of the river, however, the water was so clear that it filtered through in places and this automatic closing of leaks did not occur. A little extra pumping was required before the leaks were stopped.

A generally similar style of cofferdam was used for the other parts of the work. On the outside, the dredged material is banked up against the sheeting, and is in some places paved with rip-rap stone to protect it from scour by the current. Protection against ice is afforded by large cribs filled with stone, and by a row of pile clusters (three piles in each group). The clusters are about 15 ft. apart, and the piles are bound together by wire cables. The cribs are 16 ft. square, rising to a height of about 18 ft. above low water. They are built of 8 × 10-in. timbers, put together with 26-in. drift bolts. Some of the cribs have been displaced by the great pressure of the ice, and additional work is required on these defenses before each winter begins.

During the construction of the cofferdam, dipper dredges excavated the loose material within the enclosed space, so that there was comparatively little dry excavation to be done after the cofferdam had been closed and the space pumped out. For this latter work, grab buckets handled by traveling derricks were largely used. Hand shoveling was also employed, the material being loaded into buckets which were placed on flat cars to be hauled by mules over a narrow gage railway to the traveling or fixed derricks. Concrete was distributed in the same way, steel dump buckets being used.

In the construction of the lock and guide walls, two cableways of 300-ft. span were employed. These were used to remove the excavated material, deliver concrete, handle material, and erect the steel work of the rolling lock gates. All work on the dam proper, however, is being done by the aid of stationary derricks in the pit and at the concrete mixing plant, and by traveling derricks which run on tracks laid along the cofferdams. All these derricks [illegible] of the stiff-leg type, and each has its own [illegible]am engine.

All masonry is of monolithic concre[illegible]ounded upon bed rock. The lock walls were [illegible] in 50-ft. sections, with vertical expansion [illegible]. The faces of adjacent sections have to[illegible]-and-grooved joints, but the surfaces are [illegible] from uniting by means of a thin coating of [illegible]. The base of the movable dam is made [illegible]ctions, each section extending the full wid[illegible] of the base. Each of these sections, also, [illegible]uilt in two beds or layers. The lower or [illegible]dation bed has two parallel trenches in the t[illegible] (parallel with the line of the dam). These [illegible]rve to make a bond with the upper bed, b[illegible] one of them is used also to carry the 8-in. [illegible]ain for compressed air. The upper bed is [illegible]t 5 ft. thick.

The concrete is made with river g[illegible]el and sand, brought in mainly by barges [illegible]d tow boats, but partly by dump cars on an [illegible]electric railway. The material is washed and screened at the dam, and is so proportioned as to range from fine to coarse sand and from coarse sand to 2½-in. pebbles. Machine mixing is used throughout. All cement is furnished by the government. The proportioning, mixing and laying of the concrete are under close supervision by government inspectors. The mixture is made quite wet, in order to obtain a dense concrete, and the work has proved quite watertight in places where it has water at a considerable head along one side.

The work is carried on day and night. This requires three eight-hour shifts, as the law forbids contractors on government work to work

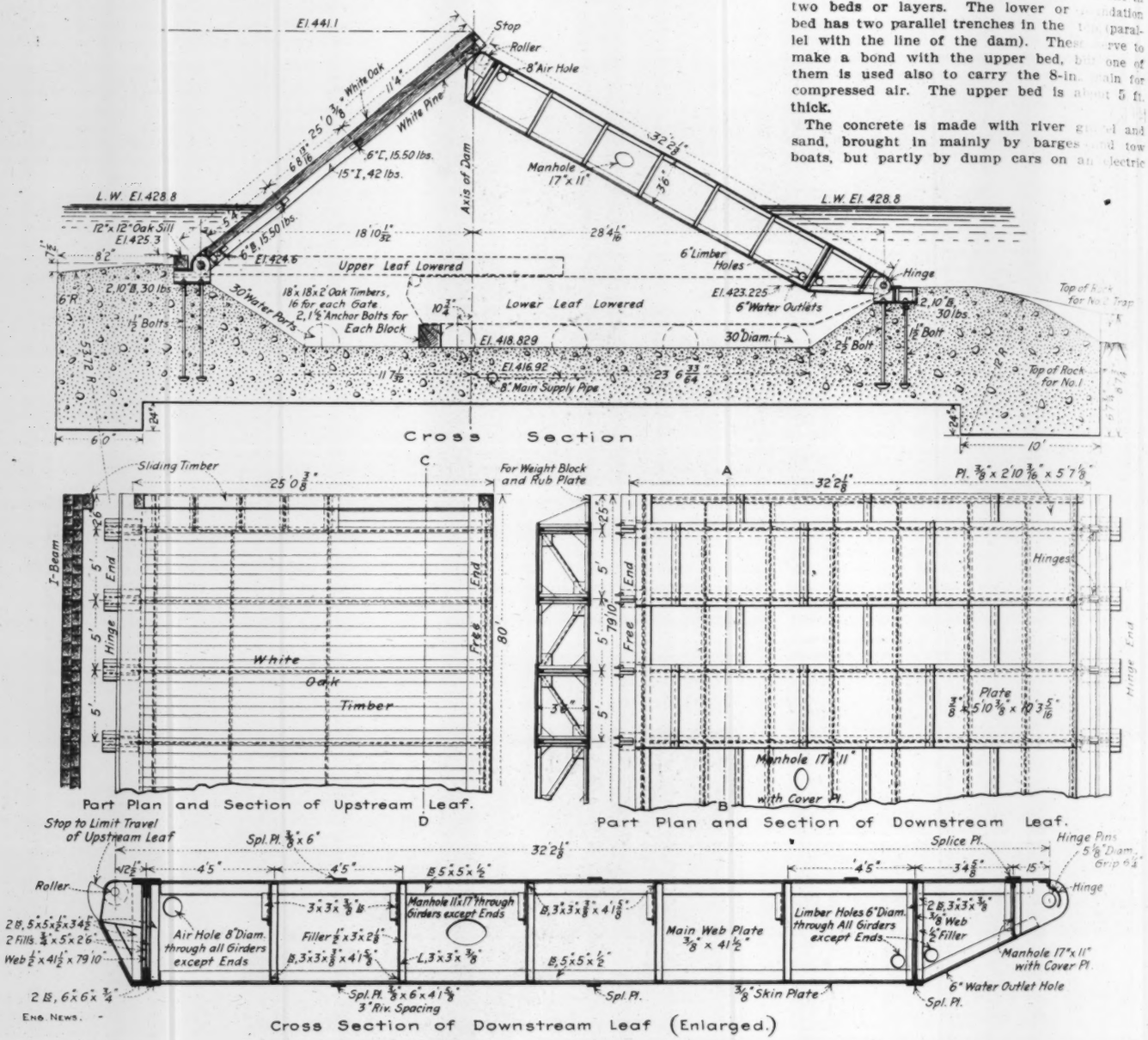

FIG. 7. BEARTRAP DAM FOR OHIO RIVER DAM NO. 37; NEAR CINCINNATI, O.

their men more than eight hours per day. About 300 to 400 men are now employed.

The work was commenced in 1905 by dredging and the building of cofferdams. Some grading and excavation (both loose material and rock) was also accomplished, and a small amount of concrete foundation was put in place. Work was resumed in the summer of 1906, but was interrupted by no less than four floods. At the close of that season, about half of the concrete

FIG. 8. CONSTRUCTION OF THE STEEL LEAF OF THE BEARTRAP AT DAM NO. 3, OHIO RIVER.

work on the lock had been completed, and all but a small portion of the excavation required for the lock chamber and wall foundation. In 1907 the work on the lock was continued, subject, however, to repeated interruptions from freshets. The upper gate was also erected, with the exception of a few details.

The season of 1908 proved to be much more favorable for work than any which preceded it. By Aug. 15, the lock walls were completed, the foundation for the lower gate was laid, and the work of erecting the gate itself was begun. By Oct. 15, the lock was complete, with its gates, Poiree dams and guide walls; the cofferdam for the first 600 ft. of the navigable pass was closed, and work was in progress on the concrete foundation. The abutment on the Kentucky side is practically complete. The concrete foundations for the buildings are finished and the sewers have been laid. With an equally favorable season this year it is hoped that the work may then be completed, although 1910 is the contract time set for the completion of the entire work.

AN OCEAN BOULEVARD in New Jersey is proposed in a bill introduced into the Legislature of that state. The boulevard would extend from Atlantic Highlands on the north to Cape May on the south, and in addition there would be a cross-state boulevard connecting county seats from Newton, Sussex County, on the west to Cape May Court House on the southeast. These boulevards would be laid out under the direction of the State Highway Commission, composed of the Governor, the President of the Senate, the Speaker of the General Assembly and the Commissioner of Public Roads. It would be the duty of this Commission to select the routes of the two boulevards, making use of existing roads so far as possible. Roadways from curb to curb would be ceded to the state by counties and municipalities and the two boulevards, together with bridges and culverts along their routes, would hereafter be maintained and repaired as a part of the state road system. Sections of the proposed boulevards not already improved would be improved, apparently at the initiative of the several counties and municipalities, under existing legislation.

Large Rail and Billet Mills at the Gary Steel Plant.

The great steel plant built at Gary, Ind., by the Indiana Steel Co., subsidiary to the United States Steel Corporation, contains a rail mill and a billet mill which, designed without limitations of space or cost, but solely with a view to highest efficiency, are the largest and perhaps also the most interesting rolling mills of their respective types in the world. They are driven by induction motors of enormous size. Primary regard was had in designing the mills, to the desirability of eliminating labor at every possible point, and combining the conflicting requirements of automatic operation and greatest simplicity.

The United Engineering & Foundry Co., of Pittsburg, Pa., designed and constructed these mills. The following particulars are from information supplied by the builders.

Rail Mill.

The mill is designed for rolling rails direct from the ingot, without reheating. The ingots are 20 × 24 ins., weighing 8,000 lbs. In the first nine passes the ingot is broken down to an 8 × 8-in. bloom, by four two-high sets of rolls placed in tandem followed by a three-high blooming mill giving five passes. Then a horizontal bloom shear cuts the bloom into two parts. From here the piece goes through nine shaping passes, the rail mill proper; this comprises a three-high roughing mill, giving three passes, and six two-high stands.

The arrangement of the stands is affected by the arrangement of the driving motors, all of which are large slow-speed induction motors (alternating current). The first four stands, two-high blooming mills, are geared, while all others are direct-connected.

BLOOMING MILLS.—The first and second stands, which are 42-in. mills, are driven by one 2,000-HP. motor, running at 214 r.p.m., and a similar motor drives the third and fourth (40-in.). The three-high blooming mill, 40-in., is direct-connected to a 6,000-HP. motor running at 75 r.p.m. Its lifting tables, however, are independently operated.

The piece is turned up after every pass in the blooming mills. The first four edgings are accomplished by the use of collared rollers on the tables which turn the piece up as it passes over them, thus avoiding the necessity of stopping the piece to handle it. On the three-high mill the turning and shifting of the piece is accomplished on the rear table by vertically moving fingers with slanting tops, which rise automatically as the table rises; on the front table, after the sixth and eighth passes the manipulation is done in the same way, except that the fingers are stationary and come into play as the table drops over them.

The lifting tables which serve the three-high mill are of unusual design. The lifted parts have the enormous weight of 290,000 lbs., which made a special method of balancing necessary. The inertia of an ordinary weight balance would not well allow of the desired high speed; a hydraulic balance would also have given slow operation; finally a pneumatic balance was evolved. The balance cylinders are connected to a tank with no intermediate valves, except, of course, gate shut-off valves. The tank and cylinders are filled with compressed air at a pressure high enough to balance the table as much as found necessary. The volume of the tank can be varied by introducing oil or water (which, however, does not flow into the cylinder), which changes the ratio of the volume of the tank to the displacement of the balance-cylinder pistons; this makes it possible to secure, within reasonable limits, any desired difference between the pressures at the upper and lower positions of the tables.

The tables are lifted by a crank and connecting rod arrangement, driven by a 250-HP. Westinghouse motor. The speed of the tables is about three seconds for a stroke, the tables rising through about 42 ins. in that time. All of the lifting mechanism is placed out from under the table in a separate pit to keep the machinery well above the ground water and away from the scale coming from the tables. This arrangement made long rock shafts necessary, which in turn necessitated more than two bearings. There are four bearings used, two under the table supporting the weight, and two outside taking the side pull of the lifting mechanism. In order to overcome the need for absolute alinement between the four bearings, the shaft is cut between the two pairs and joined by sliding-plate couplings of the Oldham type, consisting of two grooved flanges keyed and shrunk onto the shafts and a

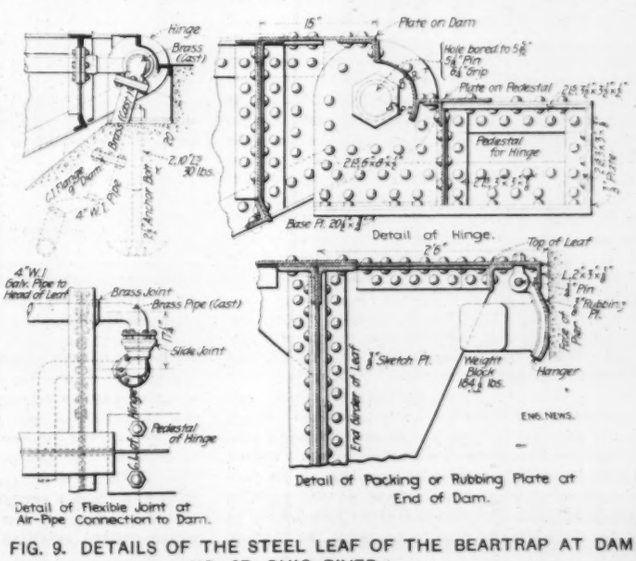

FIG. 9. DETAILS OF THE STEEL LEAF OF THE BEARTRAP AT DAM NO. 37, OHIO RIVER.

central disk with two tongues at right angles, one on each face, engaging the grooves.

The automatic manipulating devices, operated by the motion of the tables, render unnecessary any controlling devices beyond those used for raising and lowering the tables and operating the roller drives. The link which operates the levers used in raising the fingers on the approach table is fastened to a weight so proportioned as to be

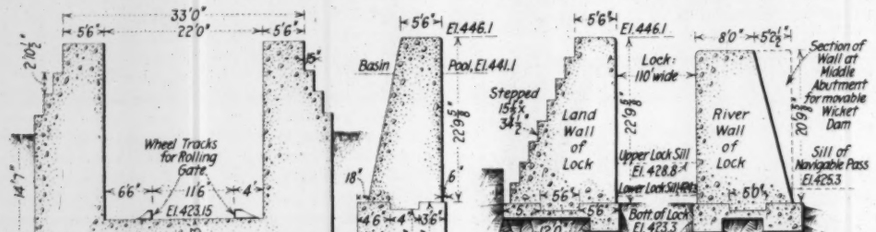

FIG. 10. CROSS-SECTIONS OF THE MASONRY WALLS AT THE LOCK AT DAM NO. 37, OHIO RIVER.

large enough to operate the manipulator, but at the same time to rise with the table in case the mechanism should become caught, thus avoiding damage to the table or manipulator.

Adjustment for wear and temperature is provided in all parts of the lifting and fixed tables. The pins and bearings are of great size, being designed for a maximum bearing pressure of 300 lbs. per sq. in. to minimize wear. The pins are hollow, and filled with oil for lubricating the bearings. The table girders are of cast steel. The rollers, also of cast steel, are hollow, and are bored and pressed on their shafts. Their bearings are self-alining. The miter-gear side has split bearings, while the opposite bearings are solid.

The driving motors of the tables are Westinghouse mill-type motors, supported by spring suspension wherever possible.

The mills themselves are all of very heavy design. The housings of the two-high blooming mills weigh about 55,000 lbs. each. They are all of the open-top type, to facilitate roll-changing. The necks of the 40-in. and 42-in. rolls are 22 ins. in diameter. The pinions are of 40-in. pitch diameter, machine molded; they are carried in bearings of the one-piece type. The pinion housings are of cast iron and are so made that the two housings of a stand, together with their single cap and the bearings, form a closed case, which protects the pinions from dirt and affords a means of thorough lubrication. The only openings in the pinion cases, as we may call them, are six small doors, two on each side and two in the cap, closed by covers hinged to the housings. The spindles and wabblers are of the usual four-pod type.

The drives for the two-high blooming mills are arranged to make the change from the motor speed of 214 r.p.m. to the speed of the mills in two reductions. The intermediate shaft carries two pinions (cast in one piece) which engage the two gears to which the mills are coupled. These gears are over 18 ft. in diameter and are machine molded. Their journals are 24 ins. in diameter; the bearings are made with quarter boxes and take-up wedges according to the best engine practice. The girders which support the drives are all bolted together, thus making practically one bed for the drive of both mills.

BLOOM SHEAR.—The horizontal shear between the blooming mill and the roughing stand of the rail mill has a capacity of 10 × 10 ins. and a speed of 12 cuts per minute. It is driven by a 75-HP. 2,000-volt alternating-current motor, and is controlled by an electrically operated clutch. Its only unusual feature is a flexible coupling connecting the motor to the shear. This coupling consists of two flanges each carrying on its face the same number of regularly spaced pins parallel to the shaft, and an endless leather belt woven in and out between the pins to transmit the motion.

A crop conveyor carries the crop ends away from the shear.

RAIL FINISHING MILL.—The nine shaping passes are given in seven stands, arranged in three groups. The first stand is a 28 × 60-in. three-high roughing mill, where the rail receives three passes. This is served by tilting tables. The other six are two-high stands, 28 × 40-in. Two of these are grouped alongside the roughing mill, the three being driven by a single 6,000-HP. motor. Beyond the roughing mill is the forming stand, driven by a 2,000-HP. motor, and beyond this is another group of three stands set side by side, driven by a 6,000-HP. motor. The speed of the roughing mill is about 60 ft. per min., that of the finishing rolls 600 ft. per min.

On the tilting tables of the three-high roughing mill the only manipulation necessary is the shifting over of the piece. This is done on the delivery table by arms which move over automatically as the table rises, and on the approach table by a simple tumble-bar arrangement.

In passing ahead from the roughing to the forming pass, collared rollers are used to turn the piece on edge, and a roller near the forming rolls with high collars holds it in position to enter these rolls. The same method is used before the dummy rolls. After leaving the dummy rolls, the piece is transferred by a chain transfer to the approach table at the first edging rolls and moves backward through these rolls. This approach has three sets of grooves in its rollers, corresponding to three duplicate passes in the rolls. By adjusting the skids of the transfer and changing the position of the release trips the flange of the rail is dropped into one or another of these grooves. The table between the first and second edging rolls has similar grooves for the rail-flange. After delivery from the second edging rolls the rail is again shifted sidewise by chain transfer returns through a pair of rolls alongside, moves forward to the last or finishing stand, which is alongside the first edging and dummy rolls.

Behind the finishing rolls are a straightening machine and the hot-saws. These latter, five in number, cut the rail into four lengths. They are 42 ins. in diameter, run at 1,400 r.p.m. and are mounted on 4½-in. nickel-steel arbors with water-cooled ring-oiling bearings. They are driven by 40-HP. 2,000-volt alternating-current motors (Westinghouse). A crank-and-pitman movement feeds all five saws down on the rail simultaneously.

From the saws the rails pass through a cambering rolls, and are then cooled, straightened and punched.

Continuous Billet Mill.

The billet mill comprises nine two-high stands arranged in tandem. After the first four passes, a turntable reverses the bloom end for end, the idea of this being to reduce as far as possible the crop-end losses due to rolling. The bloom, now 14½ × 11½ ins., then goes through two further stands of rolls, which reduce it to either 9 × 11 or 9½ × 11½ ins., and then it may either go through the last three sets of rolls for further reduction, or be switched through blind passes in these rolls. Thus the bloom is formed in from six to nine passes. Two bloom-shears beyond the last stand cut it up into billets.

The first four stands are identical with the first four stands of the rail mill, i. e., they consist of two stands of 42-in. rolls geared to a 2,000-HP. motor and two stands of 40-in. rolls similarly driven. The same size of ingot is rolled as in the rail mill, 20 × 24-in. The manipulation of the piece is done by collared rollers, as in the rail mill. The table rollers are driven through double reduction gearing by Crocker-Wheeler motors mounted on cast bases in which is journaled the intermediate gear shaft.

The turntable behind the fourth stand consists of a vertically rising circular platform, in the center of which is a flat-bottomed recess into which the bloom drops as the table rises. A row of three goads catches one side of the bloom as it falls, thus turning it on edge in the trough. A worm and wheel driven by a motor turns it end for end when the piece has cleared the table and guards, after which the table again drops it on the rollers. The table is raised by a 25-HP. Crocker-Wheeler motor geared to a crank which raises the table by a connecting-rod and a system of levers; it is balanced by a counterweight. Both the table, and its spindle are water cooled, a pipe throwing a stream of cooling-water into the hollow casting when the table is down. Spindle and worm-wheel run in an oil bath and are carefully protected from scale.

As when the table is raised a piece coming

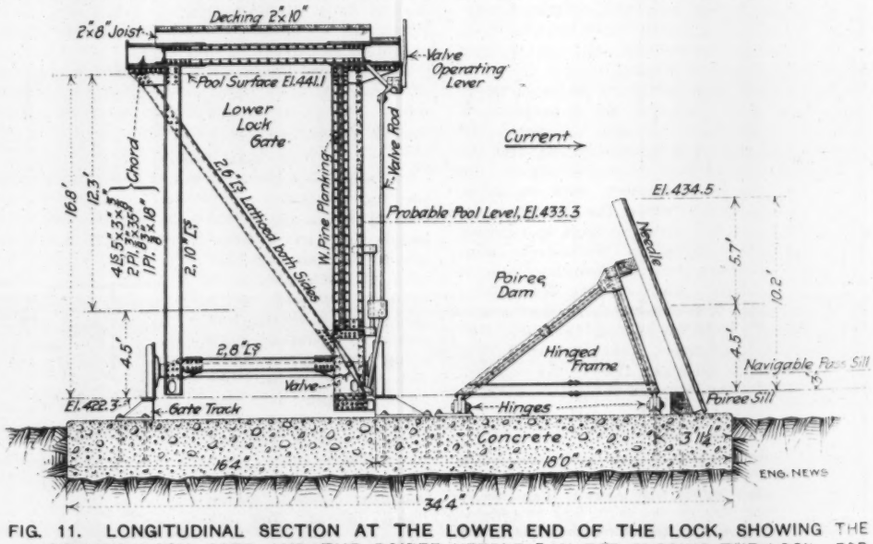

FIG. 11. LONGITUDINAL SECTION AT THE LOWER END OF THE LOCK, SHOWING THE ROLLING LOCK GATE AND THE POIREE NEEDLE DAM FOR CLOSING THE LOCK FOR REPAIRS.

through the rolls would strike the spindle, a vertically movable stop operated by the turntable is placed before the rolls, so that when the table is up it would be impossible to run a piece through the rolls. Thus for any reason a piece should strike the turntable when it is in its low position, the four bolts which hold the table on its spindle would be sheared off without overstraining the spindle.

The five two-high mills which follow are 32 × 54-in. mills in tandem. The first two have only two passes cut in the rolls, one at either end, while the last three have a pass at each end, and at the middle a blank pass large enough to clear a 9½ × 11-in. bloom. Movable switches are provided at all of the mills to guide the piece to the desired pass, and when the reduction is to be stopped before the last three passes the switches are set for the blank pass of these three mills.

A 6,000-HP. induction motor drives the group of five mills, by means of bevel gearing. The motor is on a longitudinal shaft, and five bevel pinions on this shaft engage bevel gears on the roll drives. The first four gears are 14 ft. in diameter, the fifth is 11 ft.; the teeth were planed

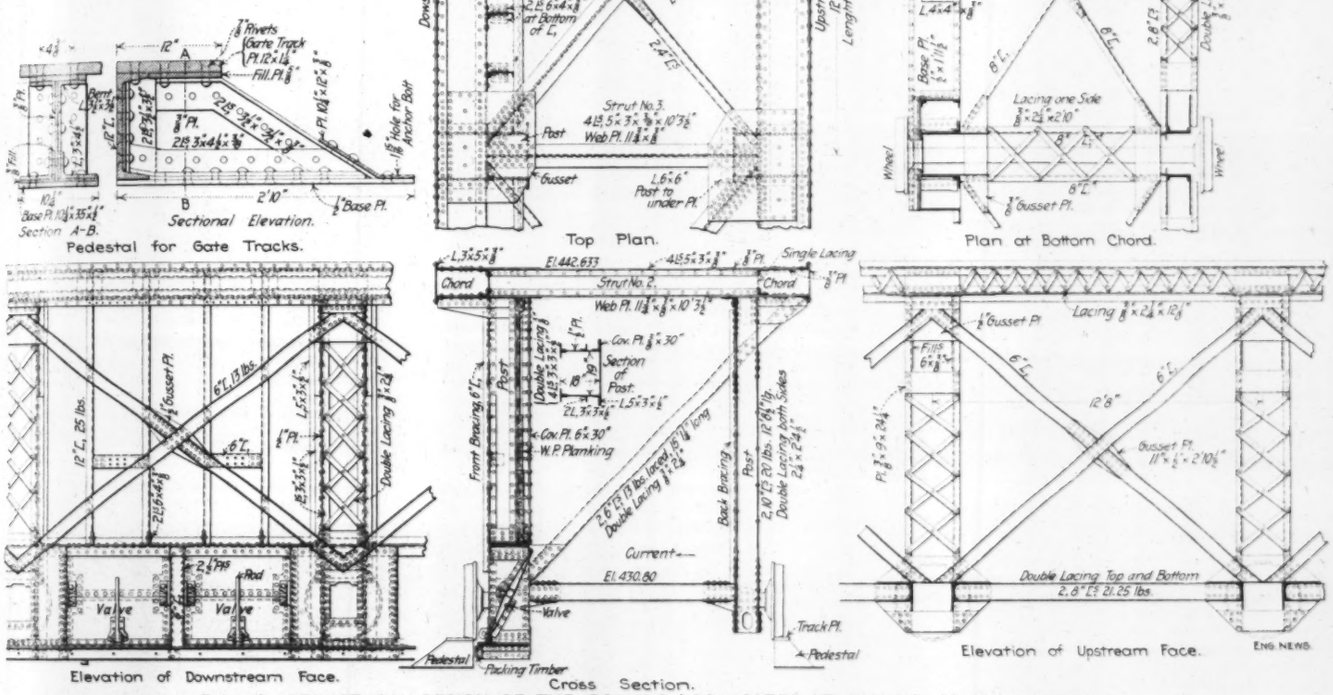

FIG. 12. STRUCTURAL DESIGN OF THE ROLLING LOCK GATES AT DAM NO. 37, OHIO RIVER.

by the Gleason Works, who built a special machine for the work.

After having passed through the last stand of rolls, the bloom may be run forward or by a chain transfer to another table alongside, the two tables serving as approach tables to the two bloom shears which mark the end of the 32-in. billet-mill.

The shear in line with the mills is of the horizontal type and has a capacity of 12 × 12 ins. It is quite similar to the horizontal bloom-shear of the rail mill. The shear alongside is a 10 × 10-in. up-cut bloom shear, driven by a 100-HP. motor connected with a flexible coupling similar to that on the horizontal shears.

The New Haven Meeting of the American Institute of Mining Engineers.

The 96th meeting of the American Institute of Mining Engineers was held at the Sheffield Scientific School of Yale University Feb. 23 to 26.

The opening session on Tuesday evening was devoted to the general subject of "The Conservation of Natural Resources," papers being contributed by a number of the prominent members of the society.

At the session on Wednesday morning the time was devoted to a paper on "A Sea-Level Canal at Panama," by Henry G. Granger, of Cartagena, Colombia. Mr. Granger in his paper repeated a number of the objections which have been raised to the lock type of canal now being built, laying special stress upon the possibility of earthquakes on the Isthmus. He then described a number of new machines for the excavation of material, which he has invented, but which have not yet been constructed. He claimed that these would move material so much more cheaply than existing engineering appliances that the amount of excavation required for a sea-level canal across the Isthmus could be completed in two years after the plant which he proposed was ready for service. In the discussion upon the paper, Mr. William L. Saunders, of New York, President of the Ingersoll-Rand Co., pointed out that Mr. Granger's inventions were still on paper only and that the government would in no way be justified in the adoption of anything of an experimental or untried nature upon a work of such importance as the Panama Canal. Mr. Saunders paid a high compliment to the efficiency of the work now being carried on at Panama, and expressed confidence that the results would be highly satisfactory to the nation. Mr. Charles Whiting Baker, of New York, Editor of Engineering News, continued the discussion, explaining the difficulties which beset the construction of a sea-level canal through the 25 miles of swamps in the lower Chagres Valley. He showed that the rivers along this part of the canal would require enormous diversion channels and controlling dams to prevent a sea-level channel from being promptly filled up with material brought in by the river's flow. Comparing the completed lock canal, with its open lake navigation, and the narrow, winding channel of the sea-level canal, he showed that the former would be much safer and more convenient for navigation. Other discussion was contributed by Captain John C. Oakes, Corps of Engineers, U. S. A., the Secretary of the International Board of Consulting Engineers of 1905-6. Captain Oakes discussed Mr. Granger's objections to the lock canal in detail, and showed their lack of proper foundation. Mr. Gustav H. Schwab, of New York, contributed a discussion favoring the sea-level plan, and written discussions were also contributed by a number of engineers.

At the session on Wednesday afternoon the principal subject was "Methods of Instruction in Schools of Mining Engineering," Prof. John D. Irving and Prof. L. D. Huntoon being the principal speakers. The subject was discussed by Prof. James F. Kemp, of Columbia University; Prof. Arthur J. Hoskin, of the Colorado School of Mines, and others. After the session closed the visitors were taken in automobiles to some of the principal buildings of the University and entertained at tea in the Hammond Mining Laboratory, a commodious building given to the University a few years ago by Mr. John Hays Hammond, the President of the Institute.

At the session on Wednesday evening a paper was read by Mr. William L. Saunders, of New York, on "Driving Headings in Rock-Tunnels."

The concluding session for the reading of papers took place on Thursday morning, when a number of miscellaneous papers were presented.

Excursions on Thursday afternoon and on Friday, with a reception by the Governing Board of the Sheffield Scientific School on Thursday evening, completed the program of the convention.

THE MANCHESTER SHIP CANAL carried traffic amounting to 4,582,496 tons in 1908 and earned a revenue of £506,975. There was a falling off of 481,313 tons from the traffic of 1907. The canal is now 28 ft. in depth throughout.

A Book of Instructions to Street Paving Inspectors.

The Paving Division of the office of the Chief Engineer, Department of Public Service, Columbus, O., has recently issued for the benefit of inspectors on street paving a pamphlet of instructions which should considerably facilitate the inspection and construction of that branch of public work. The pamphlet is about 4 × 7 ins. in size and comprises some four pages of instructions followed by four "Tables for the use of inspectors, contractors and field engineers on street paving," and blank pages for memoranda and records. The preliminary instructions are as follows:

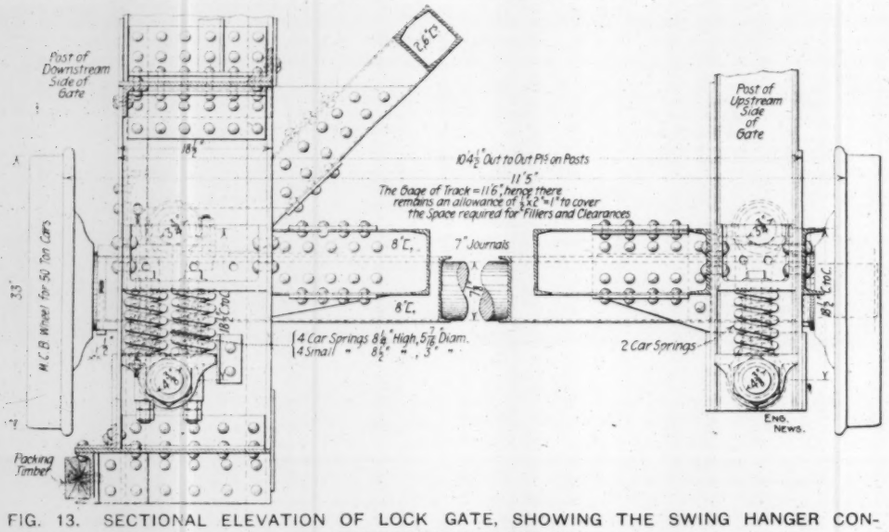
Post of Downstream Side of Gate
2.8'C.
104½" Out to Out Pls on Posts
11'5"
The Gage of Track = 11'6", hence there remains an allowance of ½"+1" to cover the Space required for Fillers and Clearances
Post of Upstream Side of Gate
7" Journals
8"C.
8"C.
8"C. Cnc.
4 Car Springs 8½" High, 5½ Diam.
4 Small " 8½" " 3" "
2 Car Springs
M.C.B. Wheel for 50 Ton Cars
33"
Packing Timber
ENG. NEWS.

FIG. 13. SECTIONAL ELEVATION OF LOCK GATE, SHOWING THE SWING HANGER CONNECTION TO THE TRUCKS.

(This allows the gate to move down-stream under pressure and thus make a water-tight seal against the sill and walls.)

INSTRUCTIONS TO INSPECTORS.
Paving.

Improvement of.....
from..... to .....
Name of Contractor.....
Kind of Pavement.....
To be Completed.....

1. As soon as you are assigned to this job and have received a copy of these instructions, apply at once to the Engineer in charge of paving for the following: A blue print copy of the improvement, a copy of the specifications and daily report cards.

2. Employment.—The city does not guarantee you continuous employment upon this improvement. As a rule you will not report until after the grading is roughed out unless sewer work is in progress at the same time. It is understood that only your actual time inspecting construction will be paid for and while upon such work you will give it your intelligent supervision.

3. Plans and Specifications.—The plans and specifications are the instruments determining the quality of material to be used and the manner of executing the work. If for any reason either fail to conform thereto it is your duty to refuse the material, stop the work and notify the office at once.

4. Report Cards.—The daily report cards are for the purpose of advising the office as to the general progress of the work and the time you were employed upon it. In case you are directed to inspect street railway construction, laying pipe or other work not under contract, you should note the time separately on the report.

5. Telephone Address.—If convenient, you should arrange for the use of a telephone near the work where you can be reached from the office quickly, as well as one at or near your home address, and leave the numbers with the Engineer in charge.

6. Accidents.—In case of accidents to employees or pedestrians make a memorandum of the time, place and report at once all the circumstances in writing to the office.

7. Stakes.—Consult with the foreman as to when lines or levels will be needed and arrange to get word to the Engineer about two days ahead so that the work will not be delayed on account of prior engagements of the field parties.

8. Obstructions.—Where poles are to be moved, pipes to be lowered, valve boxes to be readjusted, conduits rebuilt or work of like character encountered, you should make out a complete statement on the special card for report of obstructions, giving exact location and name of company whether gas, telephone, telegraph, water-works or otherwise, and hand to or mail to the Engineer as soon as stakes are set.

This office will then notify the company by letter. You must give these companies a reasonable time to satisfy the city's demand, after which notify the office again in the same way, and not to the companies direct.

The failure of such companies to remove the obstructions promptly does not warrant the rooting up of pipes or chopping into poles.

9. Subgrade.—You must satisfy yourself that the subgrade is dressed to the correct depth and crown as shown on the cross-section, and kept in shape.

No allowance for compression in rolling should be made on hard, dry clay soils.

State on your card whether rolled by city roller or not.

10. Cover Castings.—See that valve box and manhole castings are not only to grade but to the proper slope of the crown.

11. Subdrain.—See that the 4-in. drain tile is cemented into the outlets and replace any broken by roller or stakes.

12. Curbing.—Keep memoranda of the place and length of all curb redressed or reset. If possible, get all old curb reset together in the same block from which it was taken. Inspectors must not order out old curb without orders from the Engineer.

13. Circle Curb.—In case the plans do not show details of circles on slant corners, or ogees on offsets, either refer to the tables printed in the last pages of this booklet or apply to the office for the necessary information.

14. Concrete Materials.—As soon as materials for concrete begin to arrive notify the Engineer in charge.

Particular attention is called as to size and cleanliness as specified. Do not allow stone covered with mud and clay or sand that will bunch in the hand, to be unloaded. The amount of clay or loam evenly distributed allowed in the specification will not affect the quality of the mixture.

15. Cement. — Samples of about three quarts of cement should be sent in properly labeled from time to time as agreed upon, for testing purposes.

16. Mixing Concrete.—If the contractor elects to mix by hand, it is important that the sand and cement be mixed first to a uniform color before any water is added. If mixed by machine you must see that the correct proportions are used. Bear in mind that 4 sacks of cement will run about 10 sq. yds. of concrete 6 ins. deep with a 1:4:8 mixture. Measure the crown yourself and see that no mistake is made in depth or height. Read the specifications carefully and follow.

17. Laying Block.—Select 24 average blocks for a test and notify office before beginning laying.

Allow no paving sand containing pebbles, frost or lumps.

Lay intersections either diagonal or herringbone and always lay block at right angles to the curb on slant wings as well as on square wings.

Where concrete ends, and brick are laid over the foundations, make a mark on the curb with a chisel to show where the foundation stops.

18. Alterations.—Inspectors are not allowed to order any changes in the plans or incur any obligation for extra work.

Alterations or modifications are made only by the Board of Public Service, by resolution after prices for such work have been agreed upon by the parties to the contract.

Whenever such work is authorized to be paid on force account, you will be furnished a special card upon which to report. The actual time of the force employed and the rates paid must be reported daily in addition to the regular reports as long as the extra work is being done.

In order to prevent disputes in settlement, inspectors should check up their reports with the foreman each night and report disagreements, if any.

19. Records.—In this booklet are blank pages on which you may make careful record of such items that should be measured while the work is being done, for use of the Engineer in making up estimates. Give not only the quantity but the location whenever it becomes necessary to remeasure them.

Particular attention is called to keeping a strict record in this book of the following:

Length and location of all 4-in. drain tile.
Length and location of old curb redressed and reset.
No. of square yards and location of old block paving relaid upon old foundation or new foundation.
No. of square yards and location of new block laid upon old foundation.
No. of square yards and location of asphalt laid upon old foundation.
No. of square yards and location of sidewalk relaid.
No. of cubic yards of macadam or gravel measured in wagons unloaded.
No. of square yards of macadam cleaned.
Length and location and size of all sewer pipe laid.
Amount of old material used or left in place on reconstructed catch basins or manholes.

20. Return of this book.—As soon as the job is done or if you are transferred from this job to another, you must return this book with all the information contained therein to the office.

21. Acceptance of the improvement.—On completion of the work to your satisfaction you will be required to sign an acceptance of the same to be filed with the Board of Public Service.

The tables bear the following titles:

FIG. 14. DRUM AND CHAIN FOR OPERATING THE ROLLING LOCK-GATE AT DAM NO. 6, OHIO RIVER.

Table I.: Dimensions of Circle curbs on Square Corners.
Table II.: Inches and Sixteenths in Decimals of a Foot.
Table III.: Layout Data of Circles of Different Radii on Angles 60° to 120°.
Table IV.: Dimensions of Ogees or Reversed Curves on Offsets.

Mr. Ray S. Blinn is the Engineer in Charge of Paving.

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In the ages to come, the first decade of the twentieth century will stand out as marking the beginning of the great Natural Resources Conservation Movement. Started by the United States, this movement was then taken up by the several states of the Union. It soon became evident that true Conservation recognizes national no more than state boundaries, and so the national conferences held at Washington in May and December, 1908, were followed in February by the North American Conservation Conference, reported elsewhere in this issue. The logical outcome of the Continental Conference was a recognition of the desirability of a World Conservation Conference. Accordingly, President Roosevelt, who has been the leader in this great Conservation movement, has taken steps for a World Conference at the Hague, in September, 1909, with representatives of the 45 nations which took part in the last Peace Conference at that International meeting place.

The greatest good to come from these conservation conferences will be stimulative and educational in character. Stimulus and education are both sadly needed in view of the general apathy and ignorance which has prevailed heretofore and still largely exists as regards the need of conserving the natural resources of our several states, our nation, our continent and the whole world.

After awakening and enlightment on conservation must come action. In North America, the several states of the three great nations must do much independently in the way of investigation of, legislation on and administration and control of natural resources. So must the national governments themselves. International action, more particularly as regards the control of natural waters, will also be required. On other continents than ours the practical realization of the benefits of a world-wide conservation movement would, of course, follow many channels, varying with local conditions.

However it may be as to the other nations of the world, there is no question but that Canada, Mexico and the United States could learn some valuable conservation lessons at World Conservation Conferences. Some of the subjects on which Americans most need instruction and regarding which both European and Asian countries could teach us much are forest conservation and extension, water conservation and utilization (including inland navigation), protection of land from erosion and from floods, the reclamation of swamp and overflowed lands, the conservation of fertilizing materials, and the protection of the lives of men and women who work in mines, factories and shops.

Much more might be written on the possible benefits of conservation conferences, whether world-wide or more local, but the whole subject is so well treated in the "Declaration of Principles" adopted at the recent North American Conference that we prefer to use the remainder of our space to call attention to those "Principles," as given elsewhere in this issue. To that end, we need only say that reference is made, among other things, to such important matters as Continental health, as affected by the growing pollution of inland waters; to the need of forests on the headwaters of all international streams; to inland navigation; to the imperative need, on the part of every American nation, of preventing the monopoly of water power, of restricting all water-power grants to the shortest term of years consistent with safety of capital investment, and to the further need of public control of charges for power; to the reasons for restricting grants of rights to mineral fuels on public lands to terms of years; and to the desirability of permanent conservation commissions for each nation, with international interchanges of "discoveries, inventions, processes * * * seeds, seedlings," etc.; and finally to a World Conference on "world resources and their inventory, conservation and wise utilization."

May the good work go on and become world-wide. This, we think, will be the wish of every patriotic American of the three nations thus happily brought together to confer on the Conservation of Natural Resources—the very foundation of national and world prosperity.

In reporting on railway accidents for the third quarter of 1908 the Interstate Commerce Commission (in Accident Bulletin No. 29) presents a typical picture. Very few words suffice to give its two elements: (1) Four-fifths of the fatalities in train accidents occurred in *collisions*. (2) Of the eight serious collisions, seven occurred on lines where there was *no block system*, or where the system was faulty ("permissive"). This condition is very obviously full of meaning. To render it more exact, we can put it into figures; thus: Non-blocking, or so-called "time-interval" operation, caused 47 deaths, as against 24 from all other causes, and 202 injury cases, against 192 from all other causes. (The "other causes" include not only the rare block-system collisions, but all derailments, whether due to broken wheels or rails, burned bridges, landslides or what not.) The comparison calls for no comment.

The term "time-interval spacing" is a misleading and vicious term in discussions on safety of railway operation. Though it has obtained some currency, it ought to be discarded as quickly as possible. The "time-interval" is no interval at all. It is merely an unguaranteed license to a train to take its chances of finding clear track for a specified number of minutes. It is an assurance only of a slightly reduced risk of collision, and at best tells the engine-runner that until say 10.32 p. m. there is a reasonable probability that he may be able to run from Tankstop to Sagyard without meeting an opposing train. To speak of any "spacing" or "interval" under such an arrangement is simply deceptive. The Commission should be the first to avoid such a term.

A bold and ingenious scheme for partially purifying the sewage of New York City has been published by the chairman of a committee of the Merchants' Association of New York. Elsewhere in this issue we give space to a report on the plan. We do this not because we think there is the slightest possibility of the plan in its entirety ever being carried, but because modifications of it to meet the conditions peculiar to parts of the city may eventually prove desirable, and also because we welcome an apparent change towards a more rational view of sewage disposal on the part of the originator of the plan.

The scheme, in brief, is to provide some scores of sewage-treatment works, located near the numerous outlets of existing sewers, beneath the surface of cross or marginal streets. Further details of the scheme are given elsewhere in this issue.

It does not require much familiarity with sewage treatment or with underground street construction in a great city to enable any engineer to see that such a plan as this would be very costly for both installation and operation, the expense, of course, depending on the degree of purification attempted. Nevertheless, the plan is worthy of consideration. Its chief merits are: (1) its recognition of sewage disposal by dilution and (2) its adaptability to the present multiple-outfall system of sewage discharge.

A careful study of the sewage outfalls of the city might disclose many at which not even screening is yet needed, but probably at least very rough screening would be advantageous at every outlet. Rough screens, or even a series of coarse and relatively fine screens, would require little room and would cause but little expense, either for construction or operation. The addition of grit chambers for removing sand and gravel would also be a simple and not very expensive matter, and would lessen to some extent the shoaling of slips and dock fronts. The operation of either screens or grit chambers need create no nuisance.

On going beyond screens and grit chambers, and attempting to remove the finer suspended matters of the sewage, the proposed plan presents many difficulties. These include the limited area available beneath city streets, the expense and complications of construction, the high capital and operating charges, and also the possible nuisance attendant on the proposed sub-street sewage purification works. The seriousness of these difficulties would, of course, increase with the degree of purification attempted. The sites of many of the treatment works evidently contemplated by the originator of the plan would also involve questions of protection against tidal flooding. Moreover, pumping of each plant is proposed, and would cause a heavy item of expense.

Obviously, any engineer charged with purifying the sewage of a large city would prefer to avoid a multiplicity of treatment and pumping plants, particularly plants in the cramped spaces beneath city streets, and would rather concentrate his works at as a few points as possible, choosing sites where land was plentiful, cheap, and not subject to flooding.

The only justification for such a multiple-plant scheme as proposed would lie in its possible adjustment to the present system of outlets at the foot of every cross street (in Manhattan and to some exent in other boroughs). Even with the difficulties attendant on intercepting the sewage of Manhattan and piping it beneath one of the rivers to disposal works in outlying districts, one or a few disposal works would probably be less costly and far less troublesome in a variety of other ways than scores of plants on the river fronts—unless only a minor degree of purification were attempted.

What we look to see at some future time, when the authorities of New York City wake up to the need of a comprehensive study of sewage disposal matters, is (1) a continuance of the present street-foot multiple-outlet system of disposal by dilution at or near the water front for large sections of the city and for many years to come; (2) a gradual introduction of screening works and possibly grit chambers at the outfalls just designated, with a more remote possibility of setting reservoirs at a relatively few of the outlets, where individual rather than joint sewage works seem preferable; (3) intercepting or trunk outlet

sewers for districts of considerable area, where near-by disposal by dilution alone is impracticable, the sewage in such cases to receive varying degrees of treatment, according to local conditions, but the treatment works to be located, at least for the most part, above ground and where fairly ample areas are available.

It should be understood that our remarks are not intended to be adversely critical of the engineers who worked up the scheme under consideration, for they simply put in concrete engineering form the suggestions submitted to them. The only point on which we would take issue with these engineers is as regards their suggestion that in the future sprinkling filters beneath the streets may be feasible. This we doubt.

Finally, we wish to point out that the scheme proposed, especially when considered in the light of modifications needed to make it workable, proposes to do for the sewage of New York substantially what the Passaic Valley Sewerage Commission proposes for the sewage of Newark, Paterson, the Oranges, etc., that is, remove some of the suspended matters by screening and sedimentation and then have recourse to disposal by dilution and dispersal. The chief difference between the two plans is that due to the abundance of water around and within New York City, thus permitting a multitude of outlets close at hand, whereas the New Jersey communities have to rely upon a single and lengthy main outlet to reach water sufficient in volume for disposal by dilution.

The number of engineering societies in this country is very large, and is rapidly increasing. Wherever multiplication of such societies tends to weaken the strength of existing societies it is hurtful to the profession. There is, however, still a field for the organization of societies representing local interests. In another column we have noted the recent organization of two new societies of this class; the Engineering Society of Wisconsin and the Illinois Water Supply Association, each of which covers the technical interests of a single state.

The state engineering associations are important aids in the education of the younger engineers, and also in the education of the public (and of legislatures) as to the need for action for public benefit along certain lines. These local societies are in no sense rivals or competitors of the great national societies. On the contrary, they serve to a great extent as auxiliaries of the latter, since it is often easier for a young engineer to pass from a local to a national society than it would be for him to begin by becoming a member of the latter. There is also a large element of personal interest and acquaintance at the meetings of these associations, whose membership includes many engineers who are not members of or interested in the larger societies. In the same way, the reports and discussions deal largely with matters of local interest and practice within the state, few of which can find place in the proceedings of the larger societies.

Valuation and Inspection of Public Service Corporation Properties by Engineers.

The regulation of railway corporations by the federal government in matters of finance and of interstate traffic is now a well-established policy. A similar system of regulation by the state governments is also a settled policy in several states, and is developing into a policy of regulation and control of public-service corporations in general. A special feature of this state regulation in many cases is the valuation of railway property, as an aid in determining questions of rates, taxes, bond issues, etc., over which the state government may exercise control. In this class of regulation, and in the valuation of the property of these corporations, the state of Wisconsin has gone further than most of the states, for in addition to the railway and street railway companies, it covers the telegraph and telephone companies, express companies, water-power plants, and lighting and heating plants (electric and gas). The system is described at some length elsewhere in this issue, in a paper which reviews the work of the engineering staff of the commissions created by different laws for the purpose of carrying out the policy of regulation and property valuations by the state.

The general scheme of valuation was partly based upon that employed by the Michigan Board of State Tax Commissioners, as described in our issue of Dec. 20, 1900. However, the Wisconsin valuation, described by Mr. W. D. Taylor in an article which we published March 31, 1904, departs in one important respect from the Michigan method. The Michigan valuations were made by the staff of the commission, and then practically duplicated by the railways as a measure of protection. The Wisconsin valuations were made by the railways in cooperation with and under the supervision of the commission, whose engineering staff worked out the systems of detail classification for the several kinds of properties. This method of cooperation was suggested by the commission, with the view of reducing the amount of work involved in the preparation of two separate systems of valuation and their comparison when completed. The subsequent review of the valuations submitted by the railways showed that the latter had acted in good faith, and it is encouraging to note that the work was done by cooperation between instead of antagonism between the public and corporate interests.

A feature of the Wisconsin work is that in addition to the valuation, it includes an inspection system for regulating the service rendered to the public by the railways and the public utility corporations. This inspection covers such matters as train service and equipment, sanitation of station buildings, conditions of track and structures, behavior of employees, the quality of gas and electric light, accuracy of meters, etc. The results of these inspections are given to the officials of the corporations concerned, and are in many cases given also to the local papers. The publicity tends not only to aid in securing the rectification of undesirable conditions; it serves also to educate the public as to the relations between private and public interests, and to remove prejudices or false impressions as to the attitude of the corporations towards the public.

An important feature of the now general system of state control and valuation is that it is largely in the hands of engineers. In fact, the actions of the commissions are largely based upon the work of the engineering staff. And the results of this work are, in the main, accepted as correct and authoritative. Yet it is not very many years since the general attitude of the public and of public and corporate officials towards the engineer was that of regarding him as essentially a man of figures and theory. He might be a good employee, and able to take charge of certain matters of construction work, but he was considered quite unfitted to deal with commercial problems and matters of general policy. We have at different times pointed out that the engineer's training is of a character specially adapted to enable him to deal ably with broad questions of this kind, and that the well-trained engineer is specially adapted for the management of large interests, whether public or corporate. In this direction the engineer is coming into his own. As an example, the paper mentioned above shows very forcibly (though quite incidentally and not of set purpose) the important position of the engineer in the work of state regulation and control of corporate interests in Wisconsin for the benefit and protection of the public. The same has been true, of course, in other states. One point which may be mentioned here, is the important extent to which the University of Wisconsin is actively represented in the work of the Wisconsin state commissions, due to the position taken by the administration of the university as to its very practical relations with the interests of the state. In this way, there is a valuable element of "practical" work in the technical departments of the university, while it results also in educating the public as to the practical value of its educational institutions.

Canadian Routes for Deep Waterways to the Atlantic.

The article on the proposed Georgian Bay Ship Canal, in our last week's issue, deserves the careful study of all who are interested in the problem of economical transportation of grain from the interior of the continent to the Atlantic seaboard.

The detailed estimates for the Georgian Bay route show that a deep waterway, 21 ft. in size for the largest vessels now navigating the Lakes, can be built from Lake Huron to Montreal via the Ottawa River for a total cost of less than $100,000,000. If the most economical route at Montreal Island is adopted, the estimated cost is less than $94,000,000.

This compares most favorably with the expenditure which the state of New York is making on the Erie Canal enlargement. As our readers will remember, the cost of this was originally set at $101,000,000, including the enlargement of the canal leading to Lake Champlain. The New York canal when completed, however, will only accommodate large-sized barges and will require transshipment of all freight at Buffalo. It can hardly be questioned by any one that for the most economical transportation from the Lakes to the seaboard, the lake vessel itself should be brought down to tide-water to discharge its cargo.

In our opinion the most interesting thing in the report on the Georgian Bay canal project is the comparison in map and profile between this route and the Ontario and St. Lawrence route to the sea. Something of this comparison has already been given in our issue of Oct. 3, 1907, but the map and profile makes the comparison much more vivid. Instead of building the proposed locks, dams and river regulation works on the Upper Ottawa, it would only be necessary to rebuild the short Welland Canal between Lake Erie and Lake Ontario, and the chain of short canals along the St. Lawrence River from Ontario to Montreal, in order to bring the lake vessels down to tide-water.

It is true that the distance would be somewhat greater by the St. Lawrence route. In figures, the distance from Sault Ste. Marie to Montreal, by way of Lakes Huron, Erie and Ontario and the St. Lawrence, is 943 miles; whereas by the Georgian Bay route it would be 661 miles. But the saving in distance by the Georgian Bay route would be fully offset by the reduced speed through narrow channels and the delay in passing through the greater number of locks required. There are other reasons why the Lake and St. Lawrence route would be more attractive for navigation. The winter climate is less severe, so that the period of navigation would be longer; and the route lies through the most populous and wealthy section of Canada, where the largest amount of local traffic could be developed.

It is from the point of view of rapid and economical construction, however, that the St. Lawrence route appeals most strongly. Work on the Upper Ottawa would have to be carried on in a country almost uninhabited, remote from supplies and with a consequent liability to heavy expense and delays. Much of the work would be subject to more or less interference from floods and high water. In comparison, the enlargement of the St. Lawrence and Welland canals would be a work close to centers of population, and to supplies of labor and materials; and construction could be carried on without difficulty at all seasons of the year and with almost no interference or risk from floods.

It is noteworthy that in the annual report of the Canadian Department of Railways and Canals, presented to Parliament on Feb. 19, the Deputy Minister, Mr. M. J. Butler, well known as among the leading engineers of Canada, strongly recommends the enlargement of the Welland Canal. He proposes a depth of 21 ft. on the lock-sills and 25 ft. in the reaches between the locks, and he would also widen the channel

to about six times its present width. The present Welland Canal effects the drop from Lake Erie to Lake Ontario, a vertical distance of 327 ft., with 25 locks. The canal was built at a time when engineering methods and precedents did not permit what is easily possible to-day. It would be entirely practicable to rebuild the canal with a small number of locks of high lift, and thereby greatly reduce the time of passage through the canal. Such reconstruction, morever, would be comparatively inexpensive. The work would be concentrated at one point and could be done at low unit cost.

With this work accomplished, lake vessels could land their cargoes at Ogdensburg, leaving only 112 miles of rail haul necessary to deliver their cargoes at tide-water in Montreal, even with the St. Lawrence canals in their present condition. And with this much done, there can be little doubt that the enlargement of these canals, the last links in the through water route admitting lake vessels to tide-water, would promptly be undertaken.

The United States is almost as deeply interested in the carrying out of this enterprise on proper economic and engineering lines as is Canada itself. As has been shown previously in these columns, the Canadian outlet to the ocean through the St. Lawrence river and gulf must always contend against the dangers of navigation on these bodies of water, where fogs and ice and rocky shores threaten the mariner for hundreds of miles. More than this, however, the great bulk of the products of the Central West which are brought to the eastern seaboard are destined for home consumption there. It is comparatively a minor portion that seeks a market in Europe.

With lake ships coming down to tide-water at Montreal, the next step doubtless will be to provide a channel by which they may pass from the St. Lawrence into Lake Champlain—the elevation of which is only 100 ft. above sea level—and thence southward through an enlarged Champlain canal to the Hudson River at Troy, and thus to the markets of the Atlantic seaboard in New York, Boston, Providence, Philadelphia, Baltimore and Norfolk.

It will be remembered that when the International Commission on Deep Waterways between the Lakes and the Atlantic presented its report ten years ago, comparative estimates were made for waterways via the St. Lawrence River and Lake Champlain and by way of Lake Ontario and the Mohawk River. It was geographical and political considerations, rather than commercial and economic, that induced the Board of Engineers on Deep Waterways to recommend the route in United States territory.

In the decade since the report of the Deep Waterways board was prepared, however, radical changes have taken place. The work on the Erie Canal enlargement has now progressed too far, it is probable, to permit a real deep waterway large enough for lake shipping to be made across New York State. Further than this, the increase in land values, and the difficulties in obtaining right of way across the state at the present time, would certainly turn the balance of economy in favor of the St. Lawrence and Lake Champlain route. If the Canadians start the ball rolling by promptly enlarging the Welland Canal, and particularly if they follow this up with the enlargement of the St. Lawrence canals, there can be little doubt that a few years hence will see the shipping of the Lakes coming down to New York City as well as Montreal, and voyaging through Long Island Sound and along the Atlantic coast as well as in the Lower St. Lawrence.

Canada will receive full benefit from her investment in such a deep waterway to the seaboard in the gain to her wheat raising provinces in the West, in the large proportion of traffic which will take the short route to Europe via the lower St. Lawrence, and in the tolls which she could readily collect without diverting traffic upon a route offering such great advantages to commerce. No other route for bringing the lake shipping to tidewater is so favorable for construction and for navigation.

Some Further Evidence Respecting the Best Type of Canal for Panama.

In our last week's issue we summarized the reasons why the lock plan for the Panama Canal is preferable to the sea-level plan. In this summary, however, brevity compelled the giving of statements without the evidence on which the statements were based. It has seemed to us desirable to take space now for the presentation of some part of the evidence which supports the lock canal plan.

We printed last week the report of the Board of Engineers that visited the Isthmus in company with Mr. Taft; and Mr. Taft himself, in public statements, has expressed the most emphatic approval of the present plan of the work and his intention to have it carried out without substantial change. The public unquestionably has great confidence in Mr. Taft's judgment and his statement has had great influence in satisfying the public that no mistake was made in the adoption of the lock plan. Congress, at the opening of a new administration, would be little likely to attempt a change in a matter of such great public importance, to which the executive is so fully committed. Further than this, the members of the House Committee on Canals who visited the works at Panama in December were fully convinced that the lock plan was the correct one and that the work was being carried on in an admirable fashion. In the Senate, the three Senators who have been prominent in attacking the lock canal plan recently, all leave the Senate by expiration of their term on March 4.

There is, therefore, no reason to apprehend any change in the plan of the work at Panama, and further discussion upon it may therefore seem unnecessary. On the other hand, there has been created in the public mind, during the past few months, quite a general opinion that the adoption of the lock canal was a mistake, and that the many distinguished engineers who have approved and supported it have made a huge blunder. This idea is still being assiduously cultivated in a few journals; although the bulk of the newspaper press, it is fair to say, has accepted the report of the board of engineers, and Mr. Taft's endorsement of that report, as finally settling the question.

It seems to us important that the public should, so far as possible, be set right on this subject, and that the members of the engineering profession, so far as their influence extends, have a duty in this matter. We recall no public discussion in recent years that has done so much to breed distrust in the public mind of the engineering profession as has the recent agitation for the sea-level canal at Panama. The idea has been put forward assiduously that there is still radical disagreement among the profession as to the proper plan to be pursued at Panama. The fact has been wholly overlooked that very much more is known on the whole subject than was the case when the majority and minority reports of the International Board were presented three years ago.

We well understand that many engineers, who have only casual knowledge of the conditions at Panama, have been influenced by the misstatements published in the daily press, and have formed the general opinion that the sea-level plan would be preferable at Panama and should have been adopted. These engineers, however, we are sure, also appreciate the fact that for correct judgment on any matter of difficult and involved engineering practice, actual study on the ground is the only method of reaching a correct and reliable opinion, and such study must be made, moreover, by engineers of sufficient experience in the particular branch of engineering concerned and with such a judicial mind to be able to render an impartial judgment on the questions involved. We believe, therefore, that most engineers, whatever casual opinions they may have formed themselves, are willing to accept the judgment of the numerous leaders of the profession, on whose advice the government adopted and has adhered to the lock plan.

It seems worth while to call attention here to two statements which have been given wide publicity in the daily press and which, for the credit of the profession, engineers everywhere ought to be in position definitely to contradict. The first of these statements is that the commission of engineers which went to the Isthmus with Mr. Taft was selected with special reference to their known opinions in favor of the lock canal plan. We are in position to say that this statement is absolutely false. The chief ground on which the lock canal plan had been attacked up to the time this commission was appointed was the safety of the Gatun Dam. The members of this commission were selected, therefore, with special reference to their expert knowledge and acquaintance with the construction of dams under varied conditions, although due consideration was given to their general experience in large problems of hydraulic engineering, their high professional standing, and their personal character and ability to judge wisely and judicially on controverted questions. It is a fact, moreover, that some of the members of the commission, who had given only casual attention to the canal work, up to the time of their appointment, were rather prejudiced in favor of the sea-level plan until their visit to the Isthmus.

A second widely published statement is that the minority members of the International Board of 1906, whose general plan was adopted for execution, "staked their professional reputations" that their estimates for the cost of the lock canal would be sufficient for its completion. We have made careful search and cannot discover anywhere any ground for such a statement, and it is well-nigh absurd on its face. No engineer of high professional standing is likely, even in casual conversation, to "stake his professional reputation" that his estimates on a projected work are sufficient, and particularly estimates made on a work of such magnitude, to be carried out under such unprecedented conditions and governed by so many unknown factors.

At another time we shall take up in more detail the difference between the estimates of 1905-6 and the present estimates for completing the lock canal. At present we may say merely that the chief reason why the cost of the work at Panama is far exceeding the estimates made by the minority board in 1906, is that the works which are now being constructed have been enlarged in many ways over the works on which their estimates were based.

There is another statement which has been widely circulated, but which to an engineer is likewise well-nigh absurd on its face. We refer to the statement that a sea-level canal could be completed for less than the cost of the lock canal. The only foundation for such a statement is a comparison between the present estimates for completing the lock canal and the estimates made three years ago for the cost of a sea-level canal. It ought to be evident to any one of common sense that the same factors which operate greatly to increase the cost of the lock canal would also operate to increase, in at least equal proportion, the cost of the sea-level channel.

It seems worth while, however, to show something of the enormous contrast between the lock and the sea-level plan in the amount of excavation required. The accompanying Fig. 1 shows profiles of the two projects, and the shaded area in each profile shows the material which would have to be excavated. It will be seen at a glance that the work on the lock canal plan is concentrated in the Culebra Cut, and that there is comparatively little to do in the long stretch of 25 miles through the Lower Chagres Valley, where most serious difficulties menace the sea-level plan, as explained by us last week.

But the contrast between these two profiles, great as it is, does not tell the whole story of the additional material required for a sea-level ditch across the Isthmus. Fig. 2 shows a cross-section of the Culebra Cut, taken at a point where the original surface was about 200 ft. above sea level. The section shows the excavation by the French at this point, then the additional amount completed since the Americans began work up to Feb. 1, 1909, next the additional excavation in this section necessary to complete the lock canal, and finally the additional excavation which would be necessary for

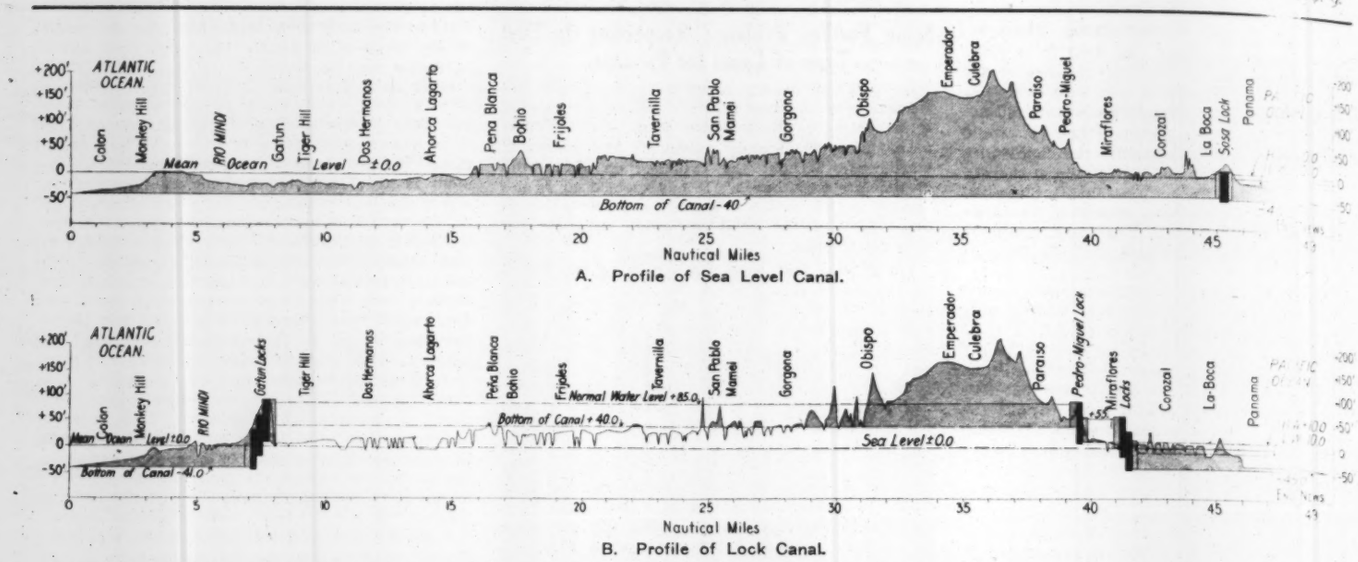


FIG. 1. LONGITUDINAL PROFILES OF THE SEA LEVEL CANAL AT PANAMA, PROJECTED IN 1906 AND OF THE LOCK CANAL NOW UNDER CONSTRUCTION.

(The shaded area on each profile shows the material to be excavated.)

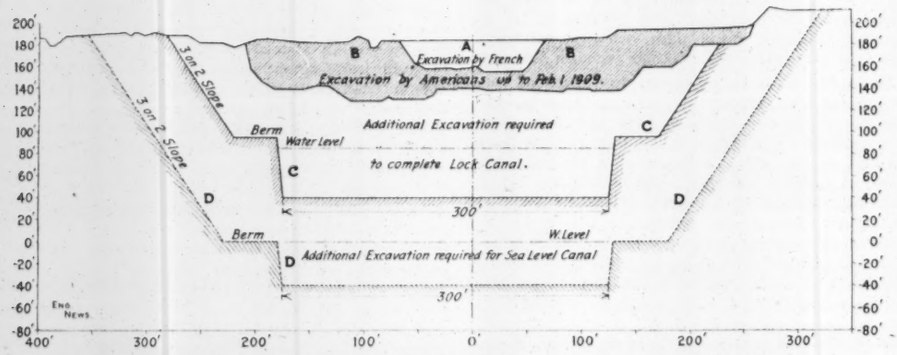


FIG. 2. CROSS SECTION OF CULEBRA CUT AT STATION 1708 SHOWING:

A. Excavation Made by the French at This Point.
B. Excavation by Americans up to February 1, 1909.
C. Additional Excavation Necessary to Complete Lock Canal.
D. Additional Excavation Necessary For a Sea Level Canal of Same Bottom Width and Slopes.

a sea-level canal having the same bottom width and the same slopes.

It is true that the sea-level canal recommended by the majority of the International Board in 1906 had a width of only 200 ft., and this indeed was the width originally adopted for the lock canal plan through the 5 miles of the Culebra Cut where the depth of excavation below the original surface is greatest. It has recently been decided, however, to increase the width of the lock canal through this 5-mile section to 300 ft., in order that large-sized vessels may pass at any point without the necessity of one of them tying up to the bank. For a fair comparison of the lock and the sea-level plan, therefore, equal width of channel should be adopted.

There is another matter which would greatly increase the cost and difficulty of a sea-level canal, and which will be evident on a moment's thought to any engineer. As seen by the profile of the lock canal, nearly all the excavation required is at a high level. The Culebra Cut drains itself by gravity as the work proceeds, and only when the lowest point is reached will pumping be required. For the sea-level canal work, however, the enormous drainage would have to be taken care of from a tropical rainfall reaching 20 ins. a month during part of the wet season and entering every part of this huge and deep ditch. Thus the additional excavation necessary for the sea-level canal would cost very much more per cu. yd. than lock canal work is costing.

We have alluded above to the contrast in width between the sea-level canal recommended in the majority report of 1906 and the present lock canal. The accompanying cut, Fig. 4, shows from official records the comparative alinement and comparative width of sailing channels in the two projects, for the 25 miles from Gatun to Gamboa. The lock canal, it will be remembered, in this section passes through the open waters of Gatun Lake. The sailing channel will have minimum widths of 1,000 ft. for three-fourths of this distance and 800 to 500 ft. for the balance. Further, these channels are in straight courses. A ship sailing through such channels follows range marks, and at the end of one course veers around to another. No such straight channels are possible in the sea-level plan, which is compelled perforce to wind among the hills and promontories of the Chagres Valley. These curves constitute a particular objection to the sea-level project, from the point of view of safe and convenient navigation. Through the earth sections, moreover, the sea-level canal was to have a width of only 150 ft. It is easily to be seen that for safe and rapid navigation, the lock canal plan is greatly superior.

A word in passing may be given at this point

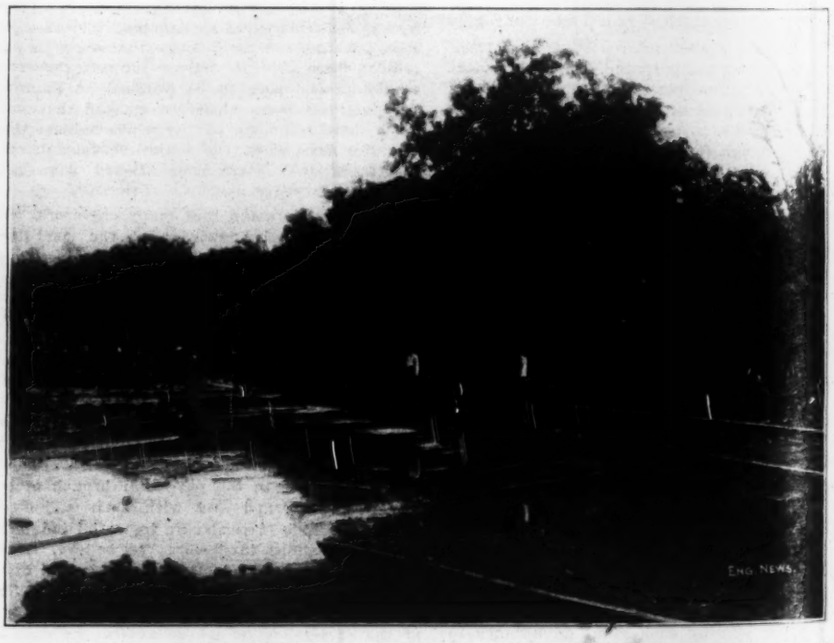


FIG. 3. SINKING OF RAILWAY TRACK OVER THE BLACK SWAMP, PANAMA R. R., SEPT. 20, 1907.

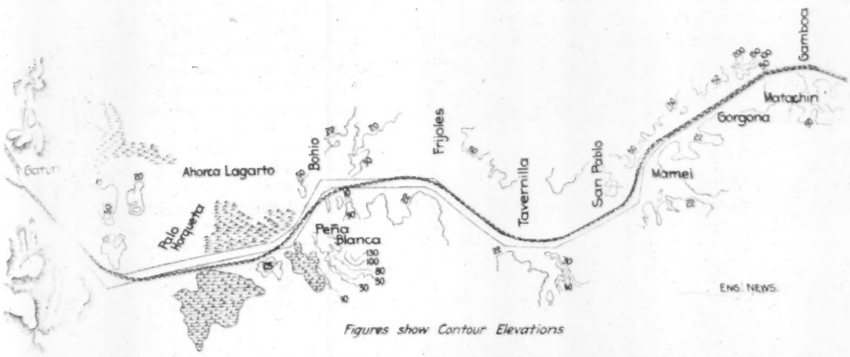


FIG. 4. THE COMPARATIVE ALINEMENT AND WIDTHS OF OPEN CHANNEL FOR 25 MILES FROM GATUN TO GAMBOA ON THE LOCK CANAL AND ON THE SEA LEVEL CANAL PROPOSED IN 1906.
(The channel of the lock canal is shown by full lines, the channel of the sea level canal by dotted lines.)

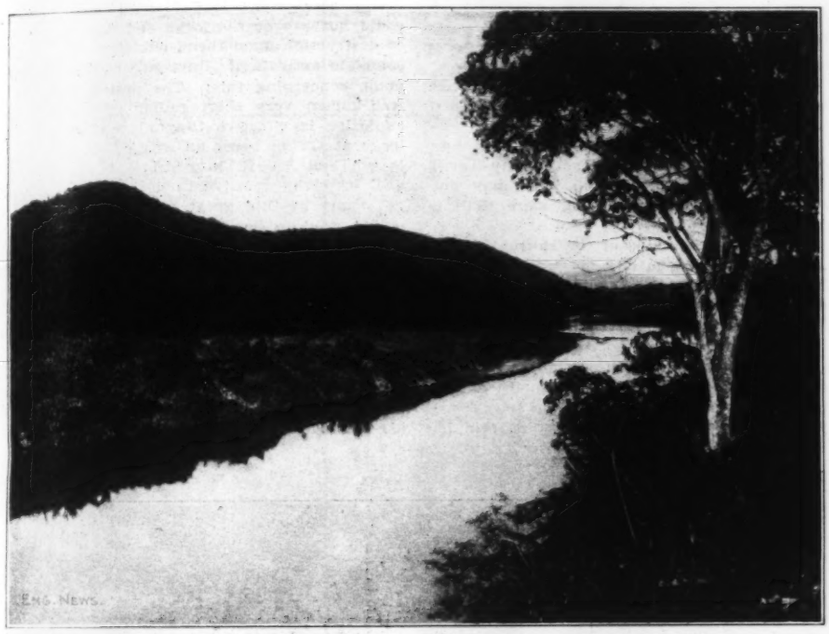


FIG. 5. THE CHAGRES RIVER NEAR GORGONA.

FIG. 6. THE CULEBRA CUT, NEAR LAS CASCADAS, SHOWING MATERIAL BROUGHT INTO CUT BY FLOODS IN THE OBISPO RIVER.

to the photographs herewith reproduced, Figs. 3, 5 and 6. Fig. 3 shows the sinking of the railway track over the Black Swamp on the Panama Railroad—an object lesson of the instability of the ground in the Lower Chagres Valley to which we referred last week. Fig. 5 is a view of the Chagres River near Gorgona, a couple of miles below the point where it intercepts the sea-level canal route. The photograph may serve to give some idea of the size of the stream whose control is a requisite to any canal across the Panama Isthmus. Fig. 6 is an illustration of the necessity of controlling or diverting other tributary streams as well as the Chagres, in any practicable sea-level canal project. It shows some of the material brought into the Culebra Cut at this point by floods in the Obispo River, an angry torrent descending from a steep watershed. Boulders are carried down in this stream, in its frequent floods, as large as a barrel, and the amount of debris is almost inconceivable to one unaccustomed to the heavy rains of this tropical region.

So far as free and safe navigation through the summit level of Gatun Lake and the Culebra Cut is concerned, even the most rabid partisan of the sea-level canal can hardly question the superiority of the present lock plan to the plan recommended by the majority board in 1906. The sea-level advocates are therefore compelled to concentrate their objections upon the locks themselves. Let us consider what weight should be given to these objections. Do the locks which are being built at Panama contain any elements of danger or difficulty at all comparable with the dangers and difficulties which beset a sea-level canal, both in construction and in use?

The objectors to the locks base their opposition on three main points. The first of these is the alleged danger which vessels will undergo in passing through the locks. So much has been printed concerning these alleged dangers that the general public, and even some engineers, appear to have obtained a greatly exaggerated idea concerning the matter. It is well, therefore, to appeal to the results of past experience. As we showed last week, in all the many years that two of the greatest ship canals of the world—the Sault Ste. Marie and the Manchester Ship Canals—have been in use, there has never been an accident in a lock sufficiently serious to obstruct navigation. In contrast with this record, the sea-level canal at Suez has been repeatedly obstructed by vessels running aground, and vessels have even been wrecked in this greatest sea-level canal of the world. Turning to our own American records, it is well known that the narrow channels connecting the Great Lakes have repeatedly been obstructed by vessels running aground or being wrecked in such a manner as to block the passage of all traffic. Nor is experience of the dangers to vessels in narrow channels confined within these limits, by any means. On Tuesday, Feb. 23, one of the largest transatlantic passenger steamers entering the port of New York ran aground in Gedney's Channel, which is the main passage from the ocean into New York Bay. On the same day, one of the largest vessels of the White Star Line, while entering the port of Boston ran aground twice on the rocky ledges at the entrance of the harbor. In both cases, the vessels were fortunately removed with comparatively little damage; but the incidents are forcible illustrations of the frequency with which vessels meet accidents in narrow and winding channels and show that the objections to a sea-level canal at Panama are based not on theory but on practical experience.

The argument has been brought forward that experience in the Sault lock is no criterion for safety at Panama, since the vessels navigating the Sault lock are all accustomed to the passage and know exactly how to handle themselves. This argument is fully met, however, by the complete system of vessel handling which will be installed at Panama, by which the movements of the vessel in the lock will be absolutely controlled by powerful electrical machinery on the lock walls, and there will be no opportunity for mistakes on the part of the vessel's crew or

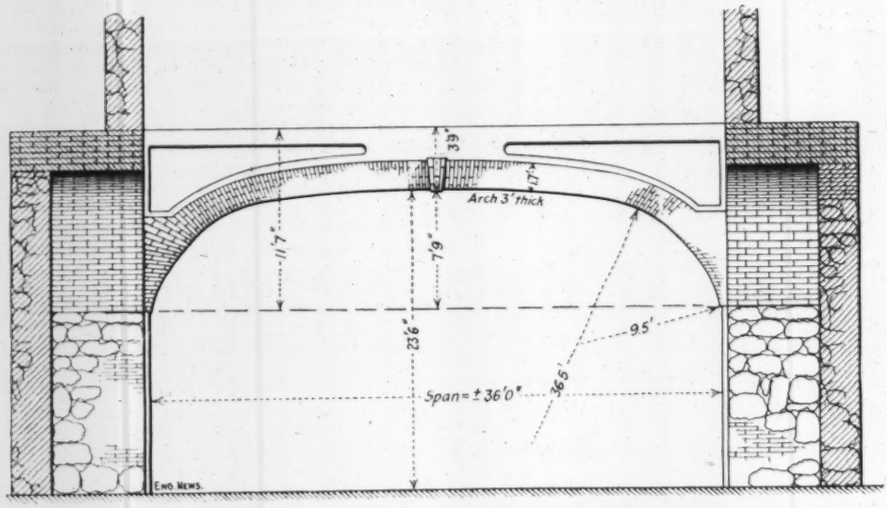


FIG. 7. ELEVATION OF FLAT ARCH IN RUINS OF SANTO DOMINGO CONVENT, PANAMA.

engine-room staff, to bring about even a minor accident.

The defenders of the sea-level plan, however, continue to lay great stress upon the earthquake argument, and draw terrible pictures of the destruction which will result the first time that an earth wave sets the Panama locks to shaking. It may be well, therefore, to get a few clear ideas of what the actual situation is respecting earthquakes at Panama.

In the first place, for the benefit of any reader who has obtained the idea that severe earthquakes are a common occurrence in Panama, we have reproduced here several recent photographs showing ruins of old churches and convents in the city of Panama. These ruins have been standing, according to our best information, since the 18th century. The flat arch in the Santo Domingo convent is one of the most remarkable illustrations of an unstable structure persisting for a century and more that we know anywhere. The dimensions of the arch are given in the accompanying elevation, obtained from official records. It may be pointed out, as it is not entirely clear from the photographs and the drawing, that the arch is a free structure, running across near the center of the building and unsupported on front or back. The story told concerning it is that it was built three times, and each time fell down; the fourth time, the priest performed some ceremony with reference to it, and, it is said, invoked the aid of his Satanic Majesty, since which time the arch has persistently stood up, regardless of any earth shocks, great or small, that may or may not have shaken the Isthmus during more than a hundred years.

In our opinion, the ruins of the church of San Jose, also located in the city of Panama and of similar age to the Santo Domingo convent, are an even more complete refutation of the idea that severe earthquakes are common there. The thin overhanging wall, supported at the base by crumbling, narrow brickwork, as well as the high unbraced gable with numerous openings, constitute two "recording seismographs" whose testimony is, so far as we can interpret it, that no very serious earthquake has visited Panama for lo! these many, many years.

Of course we recognize that Panama, or any other country, may be visited at any time by a severe earth shock; but, as we pointed out last week, the sea-level canal, with its numerous dams, spillways and other structures, would be, so far as unprejudiced judgment can determine, quite as vulnerable to a severe earthquake as would the lock canal. The massive character of the lock construction at Panama can hardly be appreciated, even by engineers, w[illegible] careful examinations of the designs and [illegible] the sites. The lock walls at Panama will [illegible] practically huge masonry dams, the central [illegible] 120 ft. in thickness and of a stability equal [illegible] of any well-designed masonry dam. Their [illegible] concrete construction, strengthened with [illegible] reinforcement in any places where stresses run [illegible] such as to make it desirable, will be about as [illegible] against an earth shock as any structure [illegible] such man builds anywhere.

A third argument of the sea-level [illegible] advocates is the alleged vulnerability of the [illegible] canal in time of war. We showed last week [illegible] that, so far as blocking the canal is concerned, [illegible] sea-level canal could be obstructed quite as [illegible] easily, and the numerous dams required for [illegible] sea-level canal would offer many opportunities for the dynamiter to effect injury. With the [illegible] lock canal on the other hand, the vulnerable points, so far as locks are vulnerable—are concentrated at two or three places, which can be effectively guarded in time of war.

Among the unique suggestions very recently made, however, is the statement that a bold aerial navigator, loaded with nitroglycerine, could hover over the locks and drop his missile of destruction upon them, effecting thereby their complete extinction! Just two remarks may be made concerning this: The first relates to the well-known very short radius over which high explosive is effective to produce damage. The locks at Gatun cover an area about 3,500 ft. in length and 350 ft. in width. It would take a deal of high explosive to destroy any considerable part of this great work, and any charge would need to be effectively placed to reach a vulnerable point. In the second place, it may be questioned what the lock-guarding force would be doing while the gentleman with the high explosive was circling in flight overhead, like a Panama vulture. In view of the effectiveness of modern small arms and their ability to deliver a hailstorm of bullets at long range, it may be predicted that long before the aerial navigator reached the proper position to drop his bomb, he and his car would be strewn over a wide area of the Canal Zone by some well-directed bullet setting off his cargo of nitroglycerine.

A final word may be worth while concerning the idea which has been very diligently spread abroad, that by some new and revolutionary method of excavating and conveying material it would be possible to dig the sea-level canal in a very short time and at very much lower cost than by the methods now in use. Particularly insistent has been the advertisement of the idea

FIG 8 VIEWS OF FLAT ARCH IN SANTO DOMINGO CONVENT.

that the cheapest and quickest way to excavate the rock of the Culebra Cut and the other portions of the canal prism is by dredging instead of excavating in the dry with steam shovels. The Lobnitz method of chopping rock to pieces under water has been hailed as a great discovery that would make a "Straits of Panama" a possibility in a short time and at small expense.

Regarding this idea, it may be said in the first place that no sensible engineer would adopt, for carrying out a great work like that at Panama, any radical novelty or untried machinery or method. To do this would be to run the gravest risk of such disaster and failure as attended the unfortunate experience of the French.

The best standard engineering practice of the present day was and is the only thing to adopt or consider at Panama. It is such practice that has been adopted for the work of excavation, and the results that are being obtained are the best possible answer to the claims of those who would advocate new and untried appliances.

In later issues we shall show in detail just what marvelous results are being accomplished by the men, machinery and methods which are now working at Panama. It is sufficient to say at present that no known devices for excavation and transportation of material could do better and more economical work than is to-day being accomplished there.

LETTERS TO THE EDITOR.

The Oldest Iron Ship.

Sir: Mr. Springer, in your issue of Feb. 25, in referring to my note on "The Oldest Iron Ship in the World," evidently supposes the adjective "oldest" to mean "earliest." That is not the idea intended to be conveyed, however. I am aware that the "Michigan" was not the first iron ship; it is not claimed that she was, but that she is the oldest iron ship in existence at this time.

In the discussion on the paper, however, Mr. D. W. Taylor, Naval Constructor, U. S. Navy, stated that she was the first iron ship built for any navy, as to which I have not precise information, though Mr. Taylor is doubtless correct. Very truly yours,

H. Penton.

814 Perry-Payne Bldg., Cleveland, Ohio, Feb. 27, 1909.

The Life of Trolley Wire.

Sir: On page 188 of your present volume you refer to trolley wire conditions. Permit me to say you have missed one very important point, namely, the action of a trolley wheel on the wire. Electric-railway managers insist upon a wheel of such hardness as to run 20,000 miles. We demonstrated that it was much more economical to have the wheel wear than the wire and that a wheel which would run not more than 9,000 miles was a source of many and great savings.

Two large lines (the best dividend payers in the country) saw the correctness of the idea, and joined with us in having a wheel made of the least possible weight. This was done by thinning the "ear" where no strength is required and by "spoking" the hub, thereby getting rid of all unnecessary metal, and reducing weight of wheel over 9 oz. It makes a great difference if the head on a hammer handle 16 ft. long weighs over 3 lbs. or under 2¼ lbs. The trolley wheel and pole is the hammer. For those two companies we made wheels with a *guarantee that they should not live beyond* 9,000 *miles.*

Where two pieces of metal are in friction contact the wear should be on the least expensive one and the wheel scrap was worth almost as much as the new metal.

So few roads could see the value of a light wheel that we stopped making them. Truly yours,

L. A. Millbank.

Walker Furnace Builders (Inc.), 45 Kilby St., Boston, Feb. 18, 1909.

The First Railway Track in America.

Sir: Just one hundred years ago, the staid citizens of Philadelphia were agog with curiosity over a strange and mysterious thing. Upon a vacant tract beside the Bull's Head tavern upon Front St. near Poplar St., there yet remained some remnants of the old line of defenses against the rebel colonists which were erected by the British troops in 1777. Here a civil engineer named John Thompson, from Delaware County, Pa., and a Scotch millwright named Somerville, were busy, during September, 1809, constructing a track of wooden rails resting upon sleepers 8 ft. apart, and having a grade of 1½ ins. to the yard. When completed it extended 180 ft. This undertaking was upon the order of Thomas Leiper, a Scotchman, who had come to Philadelphia many years before and was best known as a tobacconist. He was also one of the survivors of those soldiers of the First Troop of Philadelphia City Cavalry who had met the British at Princeton. At the time of this experiment he was 63 years old and had above $100,000 invested in turnpikes and canals in the state. He was also a contractor for stone work upon the Girard College and other important buildings in the city, the stone coming from his quarry just north of Chester, by sloops sailing up the Delaware River.

When the experimental track was ready, a car with grooved wheels was placed upon it and it was found that one horse could pull a heavy load upon the rails with more ease than several horses used upon an ordinary road. Thereupon John Thompson secured a contract to build a similar track from the Leiper quarry to the landing upon Ridley Creek, ten miles down the river, a distance of one mile.

This tramway was finished early in the following year. The son of the contracting engineer, John Edgar Thompson, afterward had an important part in the building of the early railroad lines which now form part of the Pennsylvania Railroad system and later became President of that great corporation, a position which he filled for 27 years.

The Leiper quarry tramway, upon which horses were the motive power, was in use 19 years and was the first practical rail-line built in the United States. In 1829 the energetic owner completed a canal to his quarry and the tram-line was abandoned. The old Bull's Head Tavern still stands to identify the location where Leiper's seemingly absurd and costly experiment took place, but the exact site of the first piece of track built in America cannot be definitely pointed out.

Frank H. Taylor.

718 Arch St., Philadelphia, Feb. 15, 1909.

Concerning Flat Slabs and Multiple-Way Reinforcement.

Sir: Allow me to say a few words to the very interesting article of Mr. C. A. P. Turner in your magazine of Feb. 18, 1909.

Certainly one cannot help admiring the forceful way in which an ingenious idea, the "mushroom system," has been put into practice, and acknowledging the striking examples which prove the many advantages of the system. No argument, further, is needed on what the author has to say in favor of reinforced concrete generally. But some of the points the author is representing in favor of his system should not pass without comment.

Assuredly, the main proof of the quality of a building is that it stands well, but, for the officer executing building ordinances, it can by no means be the only point of importance that other buildings built in a similar way stand well. To do full justice to everybody he must be sure that the actual factor of safety is not less than specified in his building code. Thus, if there is a certain safety required for slab-and-beam design, the same factor of safety should be proved for any other system in actual figures, based upon approved statical methods, for any other system. If there is any special requirement regarding general stiffness of the building and provision for eccentric loading of columns, this same should apply to all kinds of reinforced-concrete buildings.

From the view-point of safety I cannot see any preference for the mushroom system over slab-and-beam design. The slab and beams too do not fail when they

FIG. 9 RUINS OF THE CHURCH OF SAN JOSE, PANAMA, SHOWING UNSTABLE OVERHANGING WALL.

FIG. 10. VIEWS OF OVERHANGING WALL, SAN JOSE RUINS.

crack, and I think, as far as general stiffness is concerned—especially with regard to unequal loading of columns, and for outside columns in any case—they cannot reasonably be considered inferior to designs without ribs. The comparatively great stiffness and little deflection of the beams is, to my mind, far more of a guarantee for equal distribution of loads on columns than plain slabs, which, through their larger deflection, are bound to throw bending stresses into the column.

The author's statement that no failures have as yet occurred with the mushroom system shows at least that all the work has been executed by first-class contractors, which is to be highly commended from an engineering point of view. As everybody knows, a structure erected by a good contractor, though designed with a smaller factor of safety, stands far better than the one figured with higher safety but put up carelessly; but an inspecting city officer or any other unprejudiced person cannot make a distinction that way in favor of some system, because there is no reason why any other system should not be executed in just the same good way. If irregularity in erection should be considered at all, the danger from misplacing the steel is greater the shallower the construction; that is to say, the danger is greater in slabs than in beams, so counteracting the advantage of the greater number of bars in a multiple-way slab.

Mr. Turner's article, to my mind, is short of a most important item of information. The author does not show just how he figures slabs and columns in his building, neither can I find this information anywhere else, which fact is really astonishing in our days of publicity. Thus, the statement is without any proof that the mushroom system can be built more economically than other systems because a fair comparison, or any building law applied without prejudice, would require the same factor of safety for any slab system as for slabs and beams. Judging from his own practice the writer cannot believe that it is possible to build a beamless solid slab as economically as a slab with beams, provided the same factor of safety is being used for both.

Very respectfully,

O. Gottschalk.

Detroit, Mich., Feb. 23, 1909.

[Mr. Turner omitted to give in his article an explanation of how he figures his slabs, in spite of our remonstrance that his frankly partisan remarks would seem more fair if they did not conceal themselves behind unrevealed methods of calculation. We have reason to expect, however, that he will later endeavor to set forth his calculations in detail. So long as such explanation has not been given, the reader has no recourse but to assume (in view of Mr. Turner's frequent reference to being guided by the results of load tests) that he takes as his starting-point the amount of steel in a test slab which showed such-and-such strength, and designs all his slabs in direct proportion to this, taking their strength as being greater than that of the test slab in proportion to the ratio of their moment-capacities, i. e., the products of depth by amount of steel.

For the benefit of those few of our readers who entertain the notion that the statements in every article published in Engineering News have the endorsement and approval of the Editors, we ought to say that the notion is quite wrong. We publish many articles containing statements at variance with our own ideas. Mr. Turner's article is one of these. But we believe that many statements and views in that article may prove stimulating, and therefore beneficial; for one thing, because they are very non-conventional.—Ed.]

The Sanitary Districts of Indiana and Chicago and the Sewage Farms of Berlin.

Sir: In your editorial comment on my letter on the Sanitary Districts of Indiana and Chicago, which appeared in the Engineering News of Feb. 18, I think that inadvertently, and without intending to do so, you give an erroneous impression of the real reason why Berlin has such a large area of land under irrigation.

The city of Berlin is surrounded by a sandy plain, somewhat similar to that which is adjacent to Chicago, in the Calumet district, and the northern portion of Indiana, and in Berlin they have found it quite profitable to introduce broad irrigation upon these lands and put them under intensive cultivation, rather than adopt the later so-called bacterial or rapid methods of sewage purification; hence so large an area, which they are continuing to enlarge profitably. It is probable that all of the sewage of the entire city of Berlin could be purified upon an area of less than 1,800 or 2,000 acres by bacterial methods, did they desire, or should the economic necessity therefor be apparent.

I appreciate that the Engineering News is fully aware of this situation, and it has only occurred to me to suggest this explanation in view of the fact that others, not so well informed, might misinterpret your remarks.

Yours very truly,

John W. Alvord.

Hartford Building, Chicago, Ill., Feb. 24, 1909.

[Inasmuch as Berlin treats its sewage on farms and Mr. Alvord spoke of both Chicago and Berlin having "equal facilities in the possession of accessible irrigable lands," we naturally supposed he had nothing but sewage farms in mind. Had Chicago adopted sewage farms a half century ago it might be abandoning them now for the more rapid methods of sewage treatment which Mr. Alvord mentions, and thus be no nearer a finality in sewage disposal than Mr. Alvord originally maintained is true with the Drainage Canal scheme.—Ed.]

A Suggested Scheme for the Water-Supply of San Francisco.

Sir: Referring to the letter by Mr. J. D. Galloway, published in your issue of Feb. 4, 1909, I find that the presentation of other possible schemes for the future water-supply of San Francisco is lamentably weak. In discussing the Stanislaus River possibilities, he has not mentioned the fact that the Stanislaus Electric Power Co. has offered to supply the city of San Francisco with a water-supply of equivalent quality to that which might be derived from the Hetch-Hetchy source and which would not have many of the undesirable features of the Tuolumne River project as now understood.

Another source of supply which Mr. Galloway has not mentioned and which possesses many very desirable features is that of the Lower San Joaquin River. This proposed development would comprehend the diversion of portions of the natural flow of the Lower San Joaquin River at some desirable point below the mouth of the Stanislaus River, the pumping of the water thus diverted over the Altamont hills, the filtration of the supply, and its conveyance to San Francisco for distribution. At first thought such a scheme would appear to be undesirable, but upon closer scrutiny and a more detailed investigation of the whole situation it has been found that this project could be constructed at a cost hardly more than 50% of the Hetch-Hetchy scheme, that the cost of operation and maintenance would be correspondingly less, and that the water-supply itself would be safer from a sanitary standpoint than the unfiltered water which might be derived from the Hetch-Hetchy source. A project, very similar in general outline, was considered by Col. Mendell as early as the late '70's but did not include the filtration of the water. Since that date very little attention has been given to the Lower San Joaquin River as a possible source for San Francisco, but, in the meantime, American filtration of water-supplies has so advanced that it is now possible to convert even dilute sewage into a potable supply which would be safer than that which might be derived from such a source as the upper Tuolumne River without filtration, whose catchment area would be frequented by campers and health seekers. Careful investigations have shown that the water flowing in the Lower San Joaquin, even at the most undesirable stages, is remarkably free from sewage pollution and will undoubtedly continue to be so if the health laws of California are enforced.

The minimum flow of the stream during the years of minimum run-off has been found to be considerably in excess of the absolute maximum demands which might be made upon the stream by the cities about the San Francisco Bay. On account of the development of storage in the Sierra Nevadas in the future for the development of electrical power and for irrigation, and for other reasons, the low-water flow of the stream is bound to be increased rather than diminished as time goes on.

It is true that the project contemplates the diversion of waters from a so-called navigable stream and is, therefore, subject to certain Federal control; but careful studies have shown that such a diversion would not materially injure low-water navigation as now developed or as ultimately developed to the limit of economy.

One of the objections recently advanced against sources of supply for San Francisco other than the Hetch-Hetchy is that greedy speculators have assumed control and have demanded exorbitant sums before being willing to relinquish their rights. So far as I know, no such objection is applicable to this project and, although there are certain legal difficulties involved, it is believed that they could all be successfully overcome.

The above discussion, setting forth an outline of certain of the more salient features of the proposed development, is submitted to show that the project has true worth and because it has not been presented to the public in a true light before. In spite of the fact that statements have been published by the agents of San Francisco that a careful consideration of all the possible sources of supply has been made, it is believed that this is not true if the Hetch-Hetchy scheme [illegible] been found to be most desirable. It is to be hoped [illegible] efore, that San Francisco will eventually adopt the [illegible] economical scheme for its own water-supply, as [illegible] that the Spring Valley Water Co. is not able to [illegible] the future demands of the city in a satisfactory [illegible] (an assumption which is questioned), and that [illegible] proposition such as suggested above should be very [illegible] studied and exploited before adopting as me [illegible] other one scheme.

Yours very truly,

Elbert M. Ch[illegible]

Civil and Hydrau[illegible] Engineer,

[illegible]ley, Cal.

Sonora, Cal., Feb. 17, 1909.

[Mr. Galloway's review of sour[illegible] of water-supply for San Francisco seemed [illegible] to be quite comprehensive, but we do n[illegible] pretend to be possessed of local knowledge on [illegible] subject. Both the Stanislaus River without [illegible] the San Joaquin with filtration were considered and dismissed as undesirable sources of su[illegible] as compared with the Tuolumne, by Mr. C[illegible] Grunsky, M. Am. Soc. C. E., then city engi[illegible] of San Francisco, in his report of 1902.

We have maintained for years [illegible] that a near-by filtered surface water-supply has much to commend it as compared with a distant but unfiltered surface supply, but the San Joaquin below the mouth of the Stanislaus is some 60 miles from San Francisco, by pipe line, and so is a nearer-by rather a near-by source.

Judging from our correspondent's own statements, serious problems would have to be met in taking water from the San Joaquin. These, we infer, would include possible interference with navigation and probable uncertainties as to the adequacy and control of the summer flow of the river. It seems very questionable whether any great center of population would be warranted in vesting the adequacy of its water-supply on waters stored and released above for power and for irrigation.

The whole question is one for San Francisco and for engineers officially charged with responsibility to settle. Discussion by outsiders is wholly proper, but it should not be forgotten that, broadly speaking, the outside discussion is of a very general and irresponsible character, since those who enter into it neither have to pay the bills nor assume official or any other responsibility which will result from whatever scheme is finally adopted. In so far as the outside discussion relates to protecting the public interest in either the water-supplies of California or the natural scenery of the Hetch-Hetchy Valley it is of course justified, so long as it keeps within the bounds of reason, truth and courtesy.—Ed.]

The Engineer's Earning Power.

Sir: In your issue of Jan. 21, 1909, you have a letter under the title, "Glory vs. Dollars." It leads me to express some thoughts and put to older engineers a question which I have long had in mind.

I am a graduate civil engineer with three years' practical experience. It may be that I have been paid all that I actually earned; yet considering the time and money spent in securing my education, and the experience gained since graduating, the salary I am able to secure is too small. Judging by the contents of the letter referred to, there seem to be other young engineers who do not feel as though they had entered a very remunerative profession. It might be well for some of the older engineers to put us young fellows right if we are taking the wrong view.

From my short experience I can cite but a few examples. The first is a case of where a young engineer acted as bridge inspector on the construction of a bridge costing $50,000. He was entirely responsible for the safe erection of the bridge, but he received only $100 per month, while an ordinary bridgeman received $4 per day. The second was the construction of a six-track pile trestle 1,000 ft. long and three double-track roller-lift bridges; the engineer in charge of this work also had charge, at the same time, of a similar job about half as large. He received but $125 per month, and on this work the foreman of a pile-driver received $5 per day straight time.

In these cases the men with no responsibility and no knowledge outside of their small sphere of work received more money than the man responsible for the entire job. Judging by this, as far as actual money value goes there are many occupations requiring no long training which

pay better ... story doesn't go very far, and most of us are out for the money.

As for me, there is no work I like better, yet it is a mighty disappointing at times to contemplate being in a profession which gives work and responsibility galore and no equivalent return in money. Perhaps I may be wrong in my views. If so I would be glad to have some one tell me so.

Yours very truly,

"Three-Year-Old."

Panama, Feb. 4, 1909.

[We often heard a mature engineer refer to his early college years with the phrase "The first five years of my life." He used the phrase unconsciously, which made it the more significant. And in fact, is not the fresh ex-senior a mere sprinkling infant as concerns professional work? By the time "Three-Year-Old" has learned his 3 R's he may have occasion to feel better satisfied with his returns; or, if not, he will at least have better grounds for complaint.

The general fact is, so far as our knowledge of engineers' rates of pay extends, that the engineering graduate direct from college must take unskilled laborer's wages, or less, indeed sometimes less than a living wage. Must he not go through his apprenticeship of practice? When that is over, say after three to five years, he may look for more substantial recompense; and in the majority of cases he gets it.—Ed.]

An Important Possibility in Working Drawings.

Sir: Your editorial in the issue of Engineering News of Jan. 28, and the remarks of Mr. Low in that of Feb. 11, both under the foregoing caption, have impelled me to present the following results of my observation and use of a file of photographic miniatures, in the office of the Virginia Electrolytic Co., at Holcomb Rock, Va.

In that the system in use here is somewhat unique, and embodies the use of photographic miniatures as a part of that system, I shall presume to occupy an additional paragraph with a rapid survey of the system itself, before making the remarks more pertinent to the subject of photographic reproduction.

The tracing once made, four blueprints are taken, in case the subject is one for the foundry. One print is sent to the foundry, one to the head office, while two are retained in the file of the works office.* Of the last two, one is intended for record, the other (in the case assumed) for the machine shop, where the casting received from the custom foundry will be finished and fitted by our own mechanics. The tracing is next photographed, and three prints are mounted on black card, each card bearing at the proper corner the number paster corresponding to the number of the drawing, as recorded in the index book of the files. One mounted photograph is reserved for the works file, one for the head office, and one for deposit in fireproof quarters. The negative and the tracing are kept in separate repositories, each being a source of reproduction of prints. It will be evident, without further words, that the distribution thus effected obviates the reasonable possibility of total destruction of the records of our past experience and ideas.

Our average tracing has the dimensions 18 by 30 ins., the average photographic miniature 4 by 6 ins. The reduced drawing has, therefore, 4.44% of the area of the original. The production of each negative costs $0.35, and of each print, $0.10. The works file is kept in a filing drawer of the Globe-Wernicke system, minus the rod. This drawer is 11 ins. long, 8.25 ins. wide and 5.75 ins. deep, receiving the 5 × 8-in. mounts without difficulty. At the date of writing there are 332 mounted photographs on file, the drawer being two-thirds full.

While the reduction stated is extreme, we have never experienced any inconvenience from this cause. It is understood in our drafting-room that drawings are to be fully dimensioned, so that the practice of scaling, hazardous at best, has never reflected to the disadvantage of the photographic miniature, upon which scaling is impossible. The uses of this file are as follows:

Discussion of a drawing, or of a set of them, by a group of the works staff, is facilitated by the possibility of examining the neat little mounts about a small desk, in place of adjoining to the nearest large table, there to tack down a row of full-size blueprints, along which a peripatetic discussion would be maintained.

In our industry much apparatus involving many special castings is yearly dismantled and, with some additions of new material, is re-assembled into new form. In an actual case the writer, in designing a new assemblage, has made simultaneous reference to six photographic miniatures of the castings involved, in order to be sure at each stage of the design that no mechanical interference of the parts would occur after the job was under way. Possible a square foot of the drawing table was occupied by the mounted photographs, and the inconvenience of leaving the seat was avoided, as would have been the case had the six blueprints been tacked upon the adjacent walls.

It is assumed that all drawings worth making are also worth preserving as records of the work done. The nature of our industry has made it necessary that this be done, beyond possibility of obliteration by fire. It is evident that a safe-deposit box in a first-class fireproof vault may contain several hundred photographic miniatures, and only a less number of the original negatives, if it be so desired, without involving considerable cost, in comparison to the advantages gained.

While the nature of our work, largely experimental and patentable in its character, deters me from sending some of our most legible reproductions, I send a set of photographic miniatures of drawings pertaining to a set of three waste-gates, and the steel framing for them. While our work is essentially electrochemical in its results, we have from time to time essayed design and construction for the maintainance of our hydraulic works and buildings. Drawings of this general character are excellent examples of what has been claimed in the first instance by the editorial opinion of the paper and herein by ourselves.

Some of these drawings have pertinent bearing upon the editorial statement to the following effect: "The most serious difficulty would arise in the case of detail drawings of structural steelwork, where it has become customary to crowd the drawings with minutely complex lines of rivet-spacing figures," et seq., to the end of that paragraph. Our photographs, in the opinion of the writer, indicate the clearness which may be attained, even with the excessive reduction here employed, in work of the class referred to. While we prefer to offer these prints as they are used by our works, in place of employing a larger scale of reduction in order to create a favorable impression, it is the opinion of the writer that photographs 8 by 10 ins. would have been acceptable to the steel-fabricator to whom the large blueprints were submitted. However, the writer, in installing this structure, proposes, in honesty to himself, and to the opinion herein expressed, to use a set of these excessive reductions in the field. Whatever may not be visible to the naked eye, is easily discernible with the aid of the small magnifier commonly used by the engineer in transit work, and with no more fatigue than that experienced in reading the vernier of that instrument. Were a contractor, or other person, to be intrusted with the work, it would be well to allow an a priori study of the structure from the blueprints, with subsequent use of the miniatures in the field. With reductions to 8 by 10 ins., blueprints would be entirely superfluous at any time.

In conclusion, the writer wishes to credit the development (not the invention) of this system of photographic miniatures as used here to the General Manager of the Virginia Electrolytic Co., Mr. George O. Seward.

Yours very truly,

Harry Riley Lee, Engineer,
Virginia Electrolytic Co.

Holcomb Rock, Va., Feb. 22, 1909.

[The prints sent represent a certain class of structural steelwork, and as drawn by Mr. Lee they would, if reduced only to 8 × 10 instead of 3½ × 5½ ins., be suitable for direct use in both shop and field. Many steel drawings are very much more complex, however, for example most drawings of bridge members, and our doubts as to the applicability of the method to structural drawing had these in mind. For example, there is before us a set of drawings covering a certain bridge, from the office of a well-known bridge company, in which one sheet has a row of spacing figures containing 7 dimensions in a length of 13/16-in., most of them being such fractional dimensions as 2⅜ ins.; the sheet is 24 × 36 ins. How such a sheet may be made amenable to the reduction process is the question we had in mind in the passage of our editorial referred to.—Ed.]

Provision for Depreciation by Public Utility Corporations.

Sir: I quote the following from the Supreme Court's decision in the Knoxville water case:

> Our social system rests largely upon the sanctity of private property; and that state or community which seeks to invade it will soon discover the error in the disaster which follows. The slight gain to the consumer, which he would obtain from a reduction in the rates charged by public service corporations, is as nothing compared with his share in the ruin which would be brought about by denying to private property its just reward, thus unsettling values and destroying confidence.

This statement, coming at the close of a decision which it would appear does just what the court here deplores, leads to the belief that the court did not fully realize the true import of that part of its decision dealing with the subject of depreciation.

Speaking of the Water Company, the court says:

> It is entitled to see that from earnings the value of the property invested is kept unimpaired, so that, at the end of any given term of years, the original investment remains as it was at the beginning.

Does not this language show a fundamental misconception as to the nature of depreciation? Other parts of the decision, it should be said, adopt a different view, but I am inclined to think that the court had it in mind that a company could be so administered that an inventory on a present value basis would show a value equal to the original cost. Depreciation can, of course, be provided for out of net earnings, only by laying aside sums in a fund to be held until replacements are necessary, and, had the court had this view in mind, it is difficult to believe that they would have held, as the decision implies, that of two companies exactly alike as to first cost, age and present value of physical assets, one would be allowed to charge higher rates than the other, because it had in bank a sum equal to the depreciation from first cost, while the other had not. Either the decision means this, or it means that *neither* of the above companies would be allowed rates based on original cost, which would be the same as saying that no concern can escape partial confiscation of its earning power, because it is manifestly impossible to maintain a parity between original cost and present value (excluding reserve). Assuming, however, that the decision means that, had the Knoxville Water Company had in bank, or in liquid assets of some kind, a sum equivalent to the difference between reproductive and present values of its plant, it would have been allowed rates based on the former, the court practically says that unless a company can continuously, from its beginning to operate, earn sufficient to enable it to lay aside each year full depreciation reserves, it cannot escape loss. To those who know how difficult it is for public utilities to meet during early years ("early" may mean five or twenty), even their actual cash requirements, (due, of course, to the fact that their investment is perforce large in proportion to earnings, while the business is developing), the inability to make up in later years for depreciation which took place earlier, or, rather, to escape partial confiscation when valued before this has been done, investments in such plants will scarcely be attractive.

The decision also fails to take into account the fact that all property capable of earning a return has two values, of which one—the selling value—depends largely on age, while the other, the rental value, depends on capacity for doing work, and is a function of cost, or reproductive, value. For example, if we intend buying a house, the age of the roof interests us, as, the longer the time before it must be replaced, the greater its present worth; if, on the other hand, we intend leasing the house, we are not interested in the life of the roof, and, provided it is sound, we will not pay any more rent because the roof may be expected to last twenty years, than we would if the landlord would have to replace it in five years. Similarly, if we purchase a horse, the number of useful years remaining to him is a vital factor in the price, while, if we lease him, the work he will do is what interests us, and we will pay the same rental for an old as for a young one, provided only both are equally efficient.

Reverting now to the Knoxville case, the decision virtually says that the company having failed to provide against the depreciation which has already accrued, can be allowed in future to earn interest and depreciation on only the present value. This condemns them to ultimate bankruptcy, as when the time comes that the plant must be rebuilt, they will have accumulated only a portion of the sum necessary for a new plant.

Further than this, suppose the plant sold at the present value (that value on which the court says it may base rates) what would the purchaser have to do to receive an adequate return? Assume the purchase price to be $400,000, the reproductive price $600,000, and the average remaining life of the plant 25 years. At the end of this time, the purchaser would have received a return on $400,000, and would have accumulated a $400,000 depreciation fund. But, the cost of a new plant will be $600,000, so that he will have lost $200,000; and it will then be apparent to him that he has had a $600,000 investment (of which sum $200,000 was a deferred payment), and that he has been collecting interest and depreciation on only two-thirds of that sum. It is, therefore, clear that the purchaser of an old plant must, to escape loss, either set aside, at the time of purchase, the difference between the price paid and the cost of a new plant, as a reserve, or he must, during the remaining life of the plant, collect both current and past depreciation. In either case, the rates which he must charge will have to be based on the cost of the plant new.

It is believed that the above reasoning cannot be successfully assailed, and that the failure on the part of the court to appreciate that returns on investments and depreciation charges are functions, not of present, but of reproductive values, will work great hardship and bring about just such a condition as the court, in the

quotation with which this article begins, says should be avoided. W. H. Winslow.

Superior, Wis., Feb. 16, 1909.

[We publish our correspondent's letter since it serves to call renewed attention to the necessity of providing for depreciation in the finances of public utility corporations; but we confess our inability to find in the recent Supreme Court decision any such danger to the right of investors as he thinks it contains.

It is accepted generally as a first sound principle of finance that the full investment value of a corporation's property must be maintained from its earnings before any distribution of dividends may be made. Any other course amounts to paying dividends out of capital. The Supreme Court says that if the owners of an enterprise fail to observe this principle and use their profits up in dividends instead of keeping their capital good, they cannot complain if public authorities fix their rates on the present value of their plant instead of its original value.

It is true that expenses for replacement of worn-out parts will vary considerably from year to year; and will be comparatively light in the early years of a corporation's life. This will be partially offset usually by the increase in value of real estate holdings and by the necessary investments in extensions.

Furthermore, any court decision must be read as a whole to properly interpret its meaning. The quotation with which our correspondent heads his letter surely indicates that the courts will treat the investor as well as the public with even-handed justice.—Ed.]

The North American Conference on the Conservation of Natural Resources.*

The North American Conservation Conference between the United States, Mexico, Canada, and Newfoundland, which was in session in Washington from Feb. 18 to Feb. 23, 1909, emphasized the fact that natural resources are not confined by the boundary lines that separate nations and that the conservation of natural resources can be helped by cooperation between nations. Not only did this Conference between the peoples of the North American Continent result in a definite statement of the way in which those peoples can unite their efforts for the preservation of the natural wealth upon which the welfare of all depends, but to it is to be given the credit for being the direct impetus to President Roosevelt for calling a World's Conference on the Conservation of Natural Resources at The Hague. At the conclusion of the five-day session of the North American Conference, the ten Commissioners were so thoroughly impressed that practical good could be derived from such interchange of opinion between nations on the possibility of mutual helpfulness in conserving natural resources, that they urged the formation of permanent "Conservation Commissions" in each of the countries participating in order that the work might be facilitated in the future and they suggested to the President of the United States that he invite all the nations of the world "to join together in conference on the subject of our resources and their inventory, conservation, and wise utilization."

On the first day of the Conference, President Roosevelt received the Commissioners and addressed them briefly. He said, in part:

> This conference represents one of the many steps that have been made of recent years, looking toward a harmonious cooperation between the nations of the earth for the common advancement of all. I believe that the movement which you this day inaugurate is of the utmost importance to this hemisphere and may become of the utmost importance to the world at large.

At the conclusion of the Conference, the Commissioners transmitted to President Roosevelt a "Declaration of Principles," which the President in turn transmitted to Congress with a brief message of earnest approval.

This "Declaration of Principles," the unanimous expression of the opinion of all the nations of the North American Continent from the Arctic Ocean to Central America concerning the meaning and imperative necessity of the conservation of natural resources, is one of the most significant documents ever formulated. It is given here and speaks for itself:

*The statement introductory to the "Declaration of Principles" was kindly sent us, at our request, by Mr. Thos. R. Shipp, Secretary, National Conservation Commission, Washington, D. C.

North American Conservation Conference.

DECLARATION OF PRINCIPLES.

We recognize the mutual interests of the Nations which occupy the Continent of North America and the dependence of the welfare of each upon its natural resources. We agree that the conservation of these resources is indispensable for the continued prosperity of each Nation.

We recognize that the protection of mutual interests related to natural resources by concerted action, without in any way interfering with the authority of each Nation within its own sphere, will result in mutual benefits, and tend to draw still closer the bonds of existing good will, confidence, and respect. Natural resources are not confined by the boundary lines that separate Nations. We agree that no Nation acting alone can adequately conserve them, and we recommend the adoption of concurrent measures for conserving the material foundations of the welfare of all the Nations concerned, and for ascertaining their location and extent.

We recognize as natural resources all materials available for the use of man as means of life and welfare, including those on the surface of the earth, like the soil and the waters; those below the surface, like the minerals; and those above the surface, like the forests. We agree that these resources should be developed, used, and conserved for the future, in the interests of mankind, whose rights and duties to guard and control the natural sources of life and welfare are inherent, perpetual, and indefeasible. We agree that those resources which are necessaries of life should be regarded as public utilities, that their ownership entails specific duties to the public, and that as far as possible effective measures should be adopted to guard against monopoly.

PUBLIC HEALTH.—Believing that the conservation movement tends strongly to develop national efficiency in the highest possible degree in our respective countries, we recognize that to accomplish such an object with success, the maintenance and improvement of public health is a first essential.

In all steps for the utilization of natural resources considerations of public health should always be kept in view.

Facts which cannot be questioned demonstrate that immediate action is necessary to prevent further pollution, mainly by sewage, of the lakes, rivers, and streams throughout North America. Such pollution, aside from the enormous loss in fertilizing elements entailed thereby, is an immediate and continuous danger to public health, to the health of animals, and, when caused by certain chemical agents, to agriculture. Therefore we recommend that preventive legislation be enacted.

FORESTS.—We recognize the forests as indispensable to civilization and public welfare. They furnish material for construction and manufacture, and promote the habitability of the earth. We regard the wise use, effective protection, especially from fire, and prompt renewal of the forests on land best adapted to such use, as a public necessity and hence a public duty devolving upon all forest owners alike, whether public, corporate, or individual.

We consider the creation of many and large forest reservations and their permanent maintenance under government control absolutely essential to the public welfare.

We favor the early completion of inventories of forest resources, in order to ascertain the available supply and the rate of consumption and reproduction.

We recommend the extension of technical education and practical field instruction in forest conservation, afforestation, and reforestation, so as to provide efficient forest officers whose knowledge will be available for necessary public information on these subjects.

Believing that excessive taxation on standing timber privately owned is a potent cause of forest destruction by increasing the cost of maintaining growing forests, we agree in the wisdom and justice of separating the taxation of timber land from the taxation of the timber growing upon it, and adjusting both in such a manner as to encourage forest conservation and forest growing.

We agree that the ownership of forest lands, either at the headwaters of streams or upon areas better suited for forest growth than for other purposes, entails duties to the public, and that such lands should be protected with equal effectiveness, whether under public or private ownership.

Forests are necessary to protect the sources of streams, moderate floods and equalize the flow of waters, temper the climate, and protect the soil; and we agree that all forests necessary for these purposes should be amply safeguarded. We affirm the absolute need of holding for forests, or reforesting, all lands supplying the headwaters of streams, and we therefore fa[vor] acquisition of such lands for the publi[c]

The private owners of lands unsuit[able] once forested and now impoverished or [not] be encouraged by practical instructio[n] taxation, and in other proper ways, [to] reforesting thereof.

Notwithstanding an increasing publi[c] estry, the calamitous and far-reachi[ng] forests by fire still continues, and de[mand] and decisive action. We believe that guardianship and patrol afford the best adequately with fires which occur, wh[ether] causes, such as lightning, or in othe[r] affirm that in addition thereto effectiv[e] gently needed to reduce the vast damag[e] ble causes.

Apart from fire, the principle cause o[f] tion is unwise and improvident cutting, cases, has resulted in widespread injury and the streams. It is therefore of the [first] that all lumbering operations should be [conducted] a system of rigid regulation.

WATERS.—We recognize the waters as [a] source, and we regard their use for domes[tic] ipal supply, irrigation, navigation, and [power] related public uses, and properly subject to public control. We therefore favor the comprehensive and concurrent development of the streams and their [resources] every useful purpose to which they may [be] put.

The highest and most necessary use of water is for domestic and municipal purposes. We therefore favor the recognition of this principle in legislation, and where necessary, the subordination of other uses of water thereto.

The superior economy of water transportation over land transportation, as well as its advantages in limiting the consumption of the non-renewable resources, coal and iron, and its effectiveness in the promotion of commerce, are generally acknowledged. We therefore favor the development of inland navigation under general plans adapted to secure the uniform progress of the work and the fullest use of the streams for all purposes. We further express our belief that all waterways so developed should be retained under exclusive public ownership and control.

We regard the monopoly of waters, and especially the monopoly of water power, as peculiarly threatening. No rights to the use of water powers in streams should hereafter be granted in perpetuity. Each grant should be conditioned upon prompt development, continued beneficial use, and the payment of proper compensation to the public for the rights enjoyed; and should be for a definite period only. Such period should be no longer than is required for reasonable safety of investment. The public authority should retain the right to readjust at stated periods the compensation to the public and to regulate the rates charged, to the end that undue profit or extortion may be prevented.

Where the construction of works to utilize water has been authorized by public authority and such utilization is necessary for the public welfare, provision should be made for the expropriation of any privately owned land and water rights required for such construction.

The interest of the public in the increase of the productiveness of arid lands by irrigation and of wet lands by drainage is manifest. We therefore favor the participation of the public to secure the complete and economical development and use of all water available for irrigation and of all lands susceptible of profitable drainage, in order to ensure the widest possible benefit. Special projects should be considered and developed in connection with a general plan for the same watershed. In the matter of irrigation public authority should control the headwaters and provide for the construction of storage reservoirs and for the equitable distribution and use of the stored water.

LANDS.—We recognize land as a fundamental resource, yielding the materials needed for sustaining population, and forming the basis of social organization. Increase in the productivity of the soil is a growing need, and the possession of the land by the men who live upon it not only promotes such productivity, but is also the best guarantee of good citizenship. In the interest of the homemaker, we favor regulation of grazing on public land, the disposal of public lands to actual settlers in areas each sufficient to support a family, and the subdivision of excessive holdings of agricultural or grazing land, thereby preventing monopoly.

The preservation of the productivity of the soil is dependent upon rotation of crops, fertilization by natural or artificial means, and improved methods in farm management. The quantity and quality of crops are also dependent upon the careful selection of seed. We therefore favor the distribution by Government bureaus of scientific and practical information on these points, and we urge upon all farmers careful attention thereto.

The national importance for grazing of non-irrigable public lands too dry for cultivation, and the public loss occasioned by overgrazing, are generally acknowledged.

We therefore favor Government control of such lands in order to conserve their value, promote settlement, and increase the public resources.

The first requisite for forest or other covering which will conserve the rainfall and promote regularity of water flow is the retention of the soil upon watersheds. We therefore favor the construction of such artificial works as may effect this purpose and the encouragement thereof by remission of taxes, Government cooperation, or other suitable means.

MINERALS.—We recognize the mineral resources as forming the chief basis of industrial progress, and regard their wise use and conservation as essential to the public welfare. The mineral fuels play an indispensable part in our modern civilization. We favor action on the part of each government looking towards reduction of the enormous waste in the exploitation of such fuels, and we direct attention to the necessity for an inventory thereof. Such fuels should hereafter be disposed of by lease under such restrictions or regulations as will prevent waste and monopolistic or speculative holding, and supply the people at reasonable prices.

We believe that the surface rights and underground mineral rights in lands should be separately dealt with so as to permit the surface of the land to be utilized to the fullest extent, while preserving Government control over the minerals.

Regulations should be adopted looking to the most economical production of coal and other mineral fuels and the prolongation of the supply to the utmost. We favor also the substitution of water power for steam or other power produced by the consumption of fuel.

Great economy in the use of fuel has resulted in the past from the application of scientific inventions and the use of improvements in machinery, and further progress can be made in the same direction. We therefore recommend that all possible encouragement and assistance be given in the development and perfecting of means whereby waste in the consumption of fuel can be reduced.

The loss of human life through preventable mining accidents in North America is excessive. Much needless suffering and bereavement results therefrom. Accompanying this loss there is great destruction of valuable mineral property and enhancement of the cost of production. The best method of eliminating these known and admitted evils lies in the enactment and strict enforcement of regulations which will provide the greatest possible security for mine workers and mines. We therefore favor the scientific investigation of the whole subject of mine accidents by the Governments participating in this conference, the interchange of information and experience, and the enactment and enforcement of the best regulations that can be devised.

Mineral fertilizers should not be monopolized by private interests, but should be so controlled by public authority as to prevent waste and to promote their production in such quantity and at such price as to make them readily available for use.

PROTECTION OF GAME.—We recognize that game preservation and the protection of bird life are intimately associated with the conservation of natural resources. We therefore favor game protection under regulation, the creation of extensive game preserves, and special protection for such birds as are useful to agriculture.

CONSERVATION COMMISSIONS.—The action of the President of the United States in calling this first conference to consider the conservation of the natural resources of North America was in the highest degree opportune, and the proceedings which have followed, and the information mutually communicated by the representatives assembled, have, we believe, been conducive to the best interests of the countries participating. To derive the greatest possible benefit from the work which has already been done, and to provide proper and effective machinery for future work, there should be established in each country a permanent Conservation Commission.

When such Conservation Commissions have been established, a system of intercommunication should be inaugurated, whereby, at stated intervals, all discoveries, inventions, processes, inventories of natural resources, information of a new and specially important character, and seeds, seedlings, new or improved varieties, and other productions which are of value in conserving or improving any natural resource shall be transmitted by each Commission to all of the others, to the end that they may be adopted and utilized as widely as possible.

WORLD CONSERVATION CONFERENCE.—The conference of delegates, representatives of the United States, Mexico, Canada, and Newfoundland, having exchanged views and considered the information supplied from the respective countries, is convinced of the importance of the movement for the conservation of natural resources on the continent of North America, and believes that it is of such a nature and of such general importance that it should become world-wide in its scope, and therefore suggests to the President of the United States of America that all nations should be invited to join together in conference on the subject of world resources and their inventory, conservation and wise utilization.

Gifford Pinchot,
Robert Bacon,
James Rudolph Garfield,
Commissioners Representing the United States.
Sydney Fisher,
Clifford Sifton,
Henri S. Béland,
Commissioners Representing the Dominion of Canada.
Rómulo Escobar,
Miguel A. de Quevedo,
Carlos Sellerier,
Commissioners Representing the Republic of Mexico.
E. H. Outerbridge,
Commissioner Representing the Colony of Newfoundland.
Attest: Robert E. Young, Thomas R. Shipp,
Secretaries of the Conference.
Washington, D. C., Feb. 23, 1909.

Two New Engineering Societies.

The Engineering Society of Wisconsin.

This new state society of engineers was organized at a meeting held at the University of Wisconsin, at Madison, on Feb. 24 to 26. The meetings were held in the auditorium of the Engineering Building, and several members of the engineering staff took a prominent part.

In addition to the formal meetings, at which technical papers were read and discussed, there was a dinner at one of the university buildings. Visits were paid also to the new power station and the laboratories of the several departments. A constitution was adopted, and about 150 were enrolled as charter members.

DUST AND WEAR PREVENTION FOR STREETS AND ROADS.—One group of papers related to the methods of road construction and treatment for the purpose of reducing dust and wear of streets and roads subjected to automobile traffic. Mr. A. R. Hirst and Mr. W. O. Hotchkiss, of the Wisconsin Geological Survey, presented the first papers on the program. The former dealt with improved macadam and earth road construction for the purpose of reducing dust, wear and noise. The latter dealt with the state-aid system for the improvement of country roads, and with a new method of distributing the money granted for this purpose.

A HIGHWAY BRIDGE WITH CONCRETE FLOOR.—A steel bridge with concrete floor was described by Mr. C. V. Kerch (City Engineer of Janesville, Wis., who suggested that one of the features of a society of this kind would be the interchange of information on matters of comparatively small magnitude, which are of interest to engineers, but which would not be likely to receive notice in any other way.

The Court St. bridge over the Rock River at Janesville, Wis., has six deck plate girder spans of 40 ft. 4 ins. Each pier consists of a pair of 5-ft. steel cylinders, filled with 1:3:5 concrete, on a pile foundation. They are 26 ft. 6 ins. apart in the clear, and carry a 5-ft. plate-girder 46 ft. long, the ends extending as cantilevers beyond the piers to support the sidewalks. Upon these transverse girders rest four lines of 38½-in. plate girders 10 ft. 6 ins. apart, while upon their ends rest parallel-chord lattice trusses (of the same depth) for the sidewalks. Between the plate girders, and a few inches below their top flanges, are transverse 15-in. I-beams 60½ ins. apart. Resting on the top chords of the outer plate girders and the lattice trusses one 5-in. I-beams, with the same spacing. The I-beams at the middle and end of each span extend beyond the trusses to carry inclined braces for the hand-rail stanchions.

Upon the 15-in. I-beams is a concrete slab 6 to 9 ins. thick, giving a crown of 3 ins. This is reinforced in the bottom with ½-in. bars 4 ins. apart longitudinally and 12 ins. transversely. The concrete is a 1:2:4 mixture. The roadway portion has a 1-in. sand cushion for a 4-in. brick pavement, laid with an asphalt filler. The sidewalk slab is 5 ins. thick, reinforced with ⅝-in. bars spaced as above, and having a 3 × 3-in. curb angle. It is made with a 1:2:4 mixture, finished with 1:1½ granitoid surface 1 in. thick. It has a slope of 1½ ins. to the gutter, the curb being 4 ins. high. The roadway is 32 ft. wide, including the concrete gutters, and each sidewalk is 7 ft. wide.

FORESTRY AND WATER POWER.—These subjects and the general subject of the conservation of natural resources were covered by two or three papers. Mr. E. M. Griffiths read a paper on "The Conservation of Forests and Water Resources of Wisconsin," which was illustrated by lantern slides. The views showed the fire-inviting conditions where the "slash" or waste wood and brush is left lying among the trees. They showed also the conditions under proper forest management, where the logs and cord wood are stacked and the slash is piled in heaps so as to leave a clean forest floor between the trees which are left standing for a future crop of timber. Mr. D. W. Mead considered that while forests are important as sources of timber supply and as having an influence on water supply they are not so essential for this latter purpose as is generally assumed.

Mr. Brazeau, a state senator, discussed the legal side of water-power development, in view of the state's proposal to tax such developments. He argued that riparian owners own to the center of the stream and therefore own the water power, except that the state has reserved to itself the rights over navigation and fishing. The owners, therefore, do not require a "franchise" from the state in order to develop the power, but only a "permit" to build the necessary dam in the stream. The state, in his opinion, could not grant franchises for water power, since this power does not belong to the state. There was considerable argument on this phase of the question.

Prof. L. S. Smith, of the State Geological Survey, presented a paper on "The Water Power Resources of Wisconsin," with views illustrating a number of developed and undeveloped water-power locations.

CONCRETE DRAINS FOR STORM WATER AT MADISON.—This paper was by Mr. John F. Icke, City Engineer of Madison. The concrete used for the dams is a 1:2:4 mixture for the top, and 1:3:5 for the sides and bottom, which are faced with ½-in. of cement mortar 1:1. In some cases, the invert is faced with paving brick.

THE WATERPROOFING OF CONCRETE.—This paper, by Prof. F. M. McCullough, described some experiments made at the university. The concrete was rammed into lengths of cast-iron pipe and covered at one end with the waterproofing material under test. A cap was then attached, connected to a pipe by which water was admitted and then subjected to pneumatic pressure. We shall give particulars of these tests later. In the discussion, one member spoke of using clay in the concrete so as to make the concrete watertight in itself, instead of relying upon waterproof courses or coatings. From his tests he had concluded that from 15 to 20% of clay might be used without affecting the strength of the concrete. This matter has been discussed in Engineering News. Mr. D. W. Mead stated that he had found trouble in getting asphalt coatings to adhere to cold concrete, and in filter basins it had been partly worn off by the agitation of the sand in washing the beds. In another case, therefore, a good concrete construction was relied upon for watertightness, with no additional coating. Where clay is used, it must be very thoroughly mixed.

INTERURBAN ELECTRIC RAILWAYS.—A paper by Mr. F. G. Simmons (Milwaukee) pointed out that the conditions for establishing such lines in Wisconsin are less favorable than in Illinois, Indiana and Ohio, where they have had the most extensive development. In Wisconsin, the population is much more scattered, there are not the numerous centers of population, and the topography is in general much more irregular, so that the building of high-speed electric lines is difficult and costly. Similar topographical conditions exist in the southern part of Indiana, and there the electric railways are few. It has been suggested that lines

should be built to serve the numerous pleasure resorts in Wisconsin, but lines that have traffic for only about three months cannot be profitable. Lines that pay no interest on the investment are no benefit to the investors and of little benefit to the communities they serve. Mr. Simmons approved the law which puts the organization of such enterprises under the control of the State Railway Commission, thus eliminating "wildcat" schemes. He disapproved, however, of the law which forbids them to handle freight and parcels, and considered that this should be altered, in the interests of the railways and the communities.

Other papers were presented, dealing with electric lighting, day loads for electric generating stations, gas producers and gas power, and also describing some features of municipal engineering in the Orient and Porto Rico. A paper by Prof. W. D. Pence described the work of the engineering staff of the Wisconsin state railway and tax commissions.

After the adoption of the constitution and by-laws, Prof. F. E. Turneaure (Dean of the College of Engineering, University of Wisconsin), was elected the first President of the Society; McClellan Dodge (City Engineer of Appleton, Wis.), Vice-President; W. G. Kirchoffer (Madison, Wis.), Secretary.

The Illinois Water-Works Association.

A conference of some 20 or 25 representatives of water-works interests, engineers and the officers of a state bureau relating to water supply was held at the University of Illinois (Urbana, Ill.) on Feb. 16 and 17, and as a result of this meeting a new society was organized under the name of the Illinois Water-Works Association. The functions of this society will be two-fold: (1) to improve and distribute knowledge and information of a technical character relative to water supplies and water-works systems; (2) to aid in securing legislation for the protection or purification of water supplies. Mr. Dabney H. Maury, M. Am. Soc. C. E. (of Peoria) acted as temporary chairman, and Mr. W. J. McGonigale (of Danville, Ill.) as temporary secretary.

At the opening meeting, an address was delivered by Dr. Edmund J. James, President of the University, who spoke, among other matters, of the money loss represented by deaths, from typhoid fever. A table of deaths from this disease in Illinois at various ages (for the year 1907) showed a total of 1,119, and at the estimated value per life (ranging from $1,500 at 5 years to $6,500 from 30 to 40 years of age) the total money loss thus represented was over $5,000,000.

Following the preliminary arrangements for organization, technical matters were taken up for consideration. The first subject was "Duty of Pumping Engines and the Cost of Pumping Water;" this was a report presented by a committee at the recent annual meeting of the Illinois Society of Engineers and Surveyors in Chicago (Engineering News, Feb. 4). Prof. S. W. Parr presented a short paper on "Specifications for the Purchase of Coal." Prof. T. J. Burrill discussed the matter of self-purification of streams, relating particularly to the great reduction of bacteria in the Desplaines and Illinois rivers since the opening of the drainage canal which discharged the diluted sewage of Chicago into those streams. Dr. H. E. Barnard, Chief Chemist of the Indiana State Board of Health, described the conditions of water pollution and water supply at the south end of Lake Michigan. His address was similar to that given before the Indiana Engineering Society and reviewed recently in our columns. At the dinner given at the University Club (and this formed a not unimportant part of the proceedings), Dr. Barnard outlined the stream pollution bill now before the Indiana legislature (which is patterned upon the Ohio law), and referred to the work of the Indiana Water Association in promoting this bill.

Dr. E. Bartow, Director of the Illinois State Water Survey, discussed the relations of the State Water Survey to municipal water supplies. The Survey was established to make a chemical and biological investigation of the waters of the state. This has been interpreted to include the making of analyses of water samples submitted by local authorities or citizens, and this work has increased to such an extent that it is almost impossible (with the present funds) to make all the sanitary and mineral analyses desired. The Survey desires to place itself in the position of a clearing house, for water-works officials, information obtained from one company or place being made available for the benefit of others without injury to the first. The Survey desires also to hear from the water-works interests in regard to problems which they meet or matters which they think should be investigated as of common interest. In this connection he suggested that the new association should have an advisory committee to keep in touch with the work of the Water Survey.

While the work of the Survey is largely of chemists and bacteriologists, in studying the quality of water, its organization should be extended to include engineers to inspect and approve plans for works and to see that such plans are carried out properly. Dr. Bartow estimated that outside of Chicago the population of Illinois towns having water-works is 1,129,000, and that the values of these works is $15,,600,000, or $13.65 per capita. Of these, 60 take their supply from streams and have to face stream pollution as a common problem. The water-works interests should, he considered, demand the passage of a bill for the prevention of stream pollution. There is a possibility also in the future legislation may be needed to prevent the pollution of underground waters.

At Tolono, Ill., there was a project for the drainage of a cellar by means of a well 130 to 140 ft. deep, extending to the water-bearing sands. Some of the health authorities considered that this would involve no danger. Dr. Bartow (as representing the State Water Survey) took the broader view that there was no knowing how the well would be used in future and that some future occupant of the property might find it convenient to discharge sewage into the well. This disposal system would give no opportunity for the bacteria to become oxidized, and sooner or later they would reach wells from which water is drawn. Again, if one owner was permitted to use a well for such purpose, why should not others have the same privilege, and as a matter of fact two were in actual use. After considerable debate, the city council of Tolono passed an ordinance declaring such wells to be a nuisance and forbidding their use. The danger which they would involve is obvious.

Several other papers were presented, generally without much discussion. Methods of making bacteriological and chemical examinations of water were described by Mr. Frank Bachmann and Mr. Lewis I. Birdsall, respectively Bacteriologist and Chemist of the State Water Survey. As to the former subject, Dr. Bartow urged that laboratories should be established at water-works plants. The cost for apparatus and equipment would be from $150 upward, and the tests are not difficult, the methods being learned in a short time. Among the papers may be noted the following: "Correlations of Deep Well Records," by Prof. J. A. Udder (Augustana College); "Advantages of a Filtered Water Supply from a Business Standpoint," by Owen T. Smith (Freeport Water Co.); "A Water-Works Laboratory," by C. H. Cobb (Kankakee Water-Works) "Methods of Measuring Water," by Prof. A. N. Talbot (University of Illinois); and "The Number and Size of Fire Streams," by Geo. C. Habermeyer (University of Illinois).

It was voted to effect a permanent organization, and a constitution was adopted. This provides that the annual meetings shall be held at the University of Illinois, unless otherwise ordered by the Executive Committee. The present officers are as follows: President, Dabney H. Maury, M. Am. Soc. C. E., Consulting Engineer, Peoria, Ill.; Secretary and Treasurer, Dr. Edward Bartow, Director of the State Water Survey, Urbana, Ill.

Merchants' Association Plans for Treating New York Sewage Beneath the Street Surface.

A decidedly novel plan for treating the sewage of New York City in numerous works built beneath the street surface near the ends of cross streets or in the river-marginal streets was recently made public. The general features of the plan were suggested by Mr. Edward Hatch, Jr., Chairman of the Special Committee on the Pollution of the Waters of the New York Harbor of the Merchants' Association of New York (Room 1106, 71 Broadway, St., New York City). The engineering details of the plan were worked out by Tribus & Massa, 96 Warren St., New York City. Through the courtesy of Mr. Hatch we print below a report on the subject made by the engineers named, and reproduce one of a number of drawings submitted with the report. The report was dated Jan. 14, 1909, and was addressed to Mr. Hatch as Chairman of the above-named committee. The report follows:

The plan proposed is to build a sewer wholly or mainly under the street surface and adjacent to present sewer outlets, each sewer to serve a group of sewers, if possible.

The general plan is:

(1) To pass all sewage through screens and catch-basins, except at times of very heavy storm flow, when some of the mixed sewage and storm water would probably have to be diverted around the works.

(2) To pass all the ordinary (and up to some three times the average dry weather) flow through large tanks in which the sewage would move so slowly that upwards of half the remaining solids carried in suspension would settle to the bottom.

(3) After passing through the settling tanks the clarified sewage would be pumped overboard through the remaining section of the original sewer. As a result the sewage would be strained and very largely clarified, but not purified, except in a small degree. There would be a reduction in the number of bacteria, probably in proportion to the percentage of suspended solids removed. Offensive and unsightly floating objects would be screened out, except for some very fine particles and grease.

The sludge deposited could be disposed of in various ways:

(1) By being pumped to tank steamers which would carry it some twenty miles out in the open sea where dilution and marine life would fully dispose of all noxious matters; or

(2) By passing through filter presses so that a comparatively dry cake would be left for removal; or

(3) By drying in rotary separators.

In the plan submitted with this report the sludge-press system is shown. The comparatively dry sludge and gritty materials from the preliminary catch-basins could be removed with street sweepings and other city refuse for incineration or filling-in purposes.

Description of Plant in Narrow Streets.

This plant is to be constructed between curb lines and under the street surface, to take care of an average sewage flow of 40 acres at a rate of 100 gals. per person per 24 hrs. and a population of 15,000, or 150 gals. per capita, or 10,000 population, or for a greater number where the rate be less, or if a less thorough settling be given. The plan covers limited and unfavorable and expensive conditions. Where possible, the works should extend under the sidewalks also and have the machinery above ground.

The works replace a section of the original sewer, occupying the middle of the street, with room left for various pipes overhead or along side, and they are built of reinforced concrete or of an arch-and-steel-beam construction. A gallery for the piping is included, and additional galleries for street mains could be added near the surface.

Sewage first enters the intake, where it is deflected to one side through a coarse grating of iron bars, and flows through gates into the outer chamber of the works. The rack bars are about

6 ins. apart and keep out large floating objects. From the opposite side of the intake sewage can be passed around the works in emergency or floods.

Beyond the intake gates the screen chambers and tanks are generally in duplicate, for cleaning and repairs, being separated by a central wall which helps to support the roof.

In the outer screen chamber are two sets of bar screens, say, with 1½-in. and ¾-in. spaces, respectively, that catch all but fine floating materials; these are cleaned with rakes by men standing on the platforms. The roof at these platforms is raised to give sufficient head room. A trash box is provided to hold this refuse until its final removal.

Between these screens is a deep pit to catch gravel, sand and other heavy objects swept in by the sewers at times of heavy flow.

When more sewage gets in than can be safely admitted to the inner part of the works, the excess will rise in the outer screen chamber and flow out under a platform through the "excess outlet" to the right into the branch sewer and be discharged without further treatment. All outlets close automatically against the tide. Ordinarily all of the sewage passes the cut-off wall into the inner screen chamber through the electrically-operated gate (a) which prevents more sewage passing in than can be taken care of by the tanks and machinery.

Here are further screens of not under ⅝-in. mesh which are arranged to be hoisted for cleaning. After passing through these screens the sewage flows over a dam or weir, into a narrow channel that is connected with a recess in the wall containing a float. When more than the prearranged maximum amount of sewage runs through this channel the float, rising, throws a switch, starting the motor that closes the inlet gates sufficiently to bring the flow within the limit. Hand gates are provided for emergency. From the regulating channel the sewage flows into a pit [from which connections lead to the settling tanks.—Ed.]

The settling tanks are 125 ft. long and 8½ ft. wide and hold at least 8½ ft. depth of sewage, allowing 3½ to 4½ hrs. for passing at the rate of 1,500,000 gals. a day. During maximum flow the time is cut down to a little over one hour and less effective results follow. The flow through the tanks is continuous, the sewage flowing over weirs into a channel and out through a pipe which leads around the next pair of tanks to the pumping reservoirs. Pumps are electric-motor-driven centrifugals started and stopped by floats in the sewage and discharged into the outfall section of the sewer by a pipe.

One-half the sewage travels as described through the first pair of tanks and the other half similarly through a pipe to the second pair of tanks and finally to the pumps.

A plank may be set across the tank under the floor to stop floating grease and oil, which might, in some cases, be worth skimming off through the openings shown in the floor. In exceptional cases special grease-extracting apparatus might perhaps be installed.

When any tank has been operated for about one week the flow is stopped; the liquid then in the tank is drawn off through a stand-pipe and pumped back to be retreated. This is necessary to avoid septic or putrefactive action. There still remains in the bottom the sludge, containing solids settled out, which is then run and pushed along a channel through the pipe gallery to a bucket elevator, pump or ejector which delivers it into a storage tank. (It is from this point that it would be pumped to the tank steamers should "sea disposal" be adopted.) From the storage tank the sludge runs by gravity to a charging cylinder where, under air pressure, it is forced through a pipe to the presses in the upper floor. In these presses the excess of water is squeezed out so that the resulting substance is dry enough to be handled readily as an inoffensive, dark-colored, approximately dry cake. The liquid from the presses is very foul and is returned for retreatment in the sedimentation tanks.

Near the upper end of the works an air shaft is provided for a ventilating inlet, and at the lower end of the works an outlet shaft and entrance way. Numerous manholes are provided for access and removal of wastes. Ventilation is provided for by exhaust fan.

Marginal Street Plan.

The plan just described is for special construction under adverse conditions. One is here outlined for construction under the marginal street that can be built so as to unite a larger number of sewers and afford a common screen and catch-basin structure where the screens can be cleaned by traveling rakes and the catch-basins by bucket dredges; both unloading on belt conveyors, which conduct the materials to a point where they can be stored for shipment or perhaps largely consumed in furnaces. The screening plant shown is modeled closely after one in Manchester, England, which has been in successful operation for several years, and it would be sufficient to screen all flow, except that of maximum storms. The head-house could here be constructed above ground for boilers and other operating machinery and storage tanks, without interfering with other uses of the marginal street and access to the piers. This plant is designed to handle sewage from 100,000 people, at the same rate of flow per person as in the more restricted plan.

The portion of sewage to be settled would in this type of construction have to be pumped to the sedimentation tanks instead of flowing thereto by gravity. The sludge would run back to pits to be lifted by ejector or pumps and otherwise treated as in the plant first described. At some stages of tide the treated sewage could be discharged without pumping.

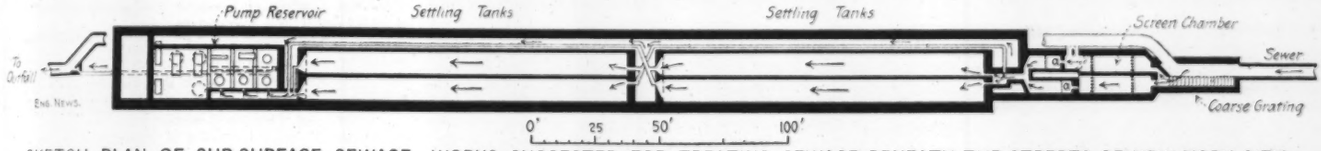
General.

To estimate the precise cost of such plants without fitting specific cases is almost impossible, but under average conditions of soil and difficulty the smaller works could probably be built for about $200,000 to $225,000, and the larger ones should be relatively much cheaper per million gallons treated.

Some treatment by chemicals might be applied in such plants without great addition, and future developments in the sprinkling filter process in the line of requiring much smaller areas than are now used might enable this process to be used underground with corresponding improved results.

Some of the appliances indicated in these drawings are perhaps not the best available, but are selected as well known types that seem more easy to understand from such a brief outline description.

Respectfully,
Tribus & Massa, by C. G. Massa.



SKETCH PLAN OF SUB-SURFACE SEWAGE WORKS SUGGESTED FOR TREATING SEWAGE BENEATH THE STREETS OF NEW YORK CITY.

AN EXPLOSION OF DYNAMITE in an excavation in East 163d St., between Ogden and Woodycrest Aves., the Bronx, New York City, Feb. 27, killed two men and seriously injured four others. Shortly before the noon hour a number of blasts were set off and afterward, when the men were breaking up the rocks with picks, one of them struck an unexploded charge.

A RAILWAY ACCIDENT IN ECUADOR Feb. 24 resulted in the death of 25 persons and the injury of 40 others. A passenger train left the track at a point near Rio Bamba and fell 100 ft. to the bottom of a ravine. The accident is ascribed to a displaced rail.

A rear-end collision between two freight trains on the Canadian Pacific Ry. Feb. 23 killed two men who were sleeping in the caboose of the forward train. The accident occurred on a sharp curve during a fog. The forward train was made up of stock cars and 35 horses were killed by the collision.

The Overland Limited, westbound on the Chicago, Milwaukee & St. Paul Ry., was wrecked Feb. 26 at Van Horn, Iowa. The engineer was killed and several persons were injured. The train was running at a speed of 60 mi. per hr. when the locomotive suddenly left the track and turned end for end. The locomotive and the baggage and mail cars were wrecked and several passenger coaches were overturned. The accident is attributed to the breaking of a flange on the locomotive.

A street car in Cleveland, Ohio, was struck by a Pennsylvania R. R. train Feb. 24. The street car was struck near the rear end and thrown around at right angles to its course. The car was heavily loaded and three of its passengers were fatally injured. Steam from the exhaust pipe of a factory is said to have concealed the approaching train from the gateman and for this reason the grade crossing gates had not been lowered.

A MINE CAVE-IN near Joplin, Mo., Feb. 26, resulted in the death of five men and two others were seriously hurt. The seven men were timbering a portion of one of the drifts of the Keystone Mine, which had been pronounced unsafe, when a slab of rock said to weigh about 300 tons, suddenly fell and was followed by loose earth. These men were alone in the part of the mine affected, but the blast of air from the mouth of the mine instantly notified those at the surface of the accident.

Accidents in the Red Jacket shaft of the Calumet & Hecla copper mine at Calumet, Mich., Feb. 26, caused the death of three men. The accidental explosion of a box of powder killed two men and the third was caught by a fall of rock.

A cave-in at the Utica mine near Angels, Cal., Feb. 19, buried four miners, three of whom were killed. The men had been at work at a point some distance beyond the point where the accident occurred and were returning to get ready for lunch.

THE GANGPLANK OF THE "KAISERIN AUGUSTE Victoria," of the Hamburg-American line, slipped from its place during the discharge of cargo at Hamburg, Germany, Feb. 24. Thirty persons were dropped into the water and 14 of them were drowned. The work of rescue was hampered by ice in the water near the dock. Reports state that those killed were stewards and stewardesses of the ship and dock laborers.

A 60-TON FLYWHEEL EXPLODED Feb. 23 at the plant of the Phillips Sheet & Tin Plate Co., in Clarksburg, W. Va. The engineer was fatally injured while trying to stop the engine and several workmen were slightly injured in the stampede from the building of the 300 employees. The engine was rated at 1,000 HP. Part of the building and machinery were wrecked by the flying fragments of the wheel, one of which, weighing 5,000 lbs., is said to have been found 500 yds. from the engine.

FLOODS ALONG THE OHIO RIVER and its tributaries last week washed out bridges and drove hundreds of families from their homes in Ohio, Indiana, Kentucky and Illinois. The floods were due to an unusually heavy rainfall over practically the entire watershed of the river. A report credited to the weather bureau places the precipitation over the area at from 2½ to 5 ins. in 36 hrs. The river rose 12 ft. at Cincinnati in 24 hrs.

THE NEWLY DREDGED CHANNEL at the Pacific terminus of the Panama Canal was opened to navigation on Feb. 1, when two Pacific mail steamships passed through it. This channel runs directly seaward in a straight course from the wharf at La Boca. This new channel takes the place of the old French channel, which passed on the other side of Culebra Island in Panama Bay. The new channel will eventually be dredged to a depth of 50 ft. at mean tide, and most of it has already reached this depth. The shoalest part at present has a depth of 30 ft. at mean tide.

THE STEAM SHOVEL RECORD for a single day's work in the Culebra Cut at Panama was again broken on Feb. 10, when 58 shovels in the central division re-

moved 76,438 cu. yds. of material, an average of 1,577 cu. yds. per shovel. The 58 shovels were under steam a total of 464 hours on that day, and were actually digging 311 hours. The material was transported an average distance of about 11 miles and made 411 train-loads.

ELECTRIC STEEL REFINING furnaces, of the Heroult type, have been adopted by the United States Steel Corporation for use in several plants, according to the "Iron Age" of Feb. 18. This is said to be the result of two years' study by the engineers of the Steel Corporation. A 15-ton furnace will be erected at the South Chicago Works of the Illinois Steel Co., and a 15-ton at the Washburn & Moen plant of the American Steel & Wire Co., at Worcester, Mass. At South Chicago the metal will be taken from a Bessemer converter for a high grade of steel rail. The output of this Heroult refining furnace will be about 500 tons per 24 hours. It is expected that there will be an unusual elimination of phosphorus and sulphur and a thorough deoxidation. The Worcester furnace will take metal from two 50-ton open-hearth furnaces for the production of high-grade steels for special wire products. It is expected that an electric furnace will be put up at Homestead, but this has not been announced.

THE RAILWAYS OF CHINA now in operation have an aggregate length of about 2,170 miles. If we include the Manchurian Railway (partly Japanese and partly Russian, under present political arrangement), and the Japanese line to Port Arthur, the total is about 3,434 miles. The lines under construction in China represent 806 miles; the lines whose construction has been provided for, 2,232 miles; and the projected lines, 3,286 miles. Up to 1894, the railways were promoted and built mainly by foreigners, but since then there has been a change in the policy, and concessions are now rarely granted. The present policy tends towards the nationalization of the railways. These particulars have been given in an article in the "Revue Generale des Chemins de Fer."

THE PRODUCTION FROM FARMS IRRIGATED by the projects of the U. S. Reclamation Service is now being recorded by the government. In most instances the land is being farmed by men ignorant of irrigation farming and often by men who know but little of any kind of agriculture, so that necessarily the production figures are not as great as may be expected when both men and machinery become more experienced. However, some of the figures published in the "Reclamation Record" show excellent results. For instance, on a 108-acre farm in the Klamath Project, California-Oregon, planted in alfalfa, barley, oats, hay and pasture there was a total estimated yield of $3,002, not counting the stock and poultry. Estimating the cost of production at $10 per acre this leaves a net return of $17.80 per acre or $1,922. In Montana, on the Huntley Project, the average yield of sugar beets has been about 15 tons per acre and these beets have been worth $5 per ton on board cars at the nearby railway station. In the same country yields of 30 bushels of wheat per acre and 60 bushels of oats have been secured. On the North Platte Project, Nebraska-Wyoming, one farmer reports 578 bushels of potatoes per acre on 1½ acres, and 40 bushels of oats per acre. In New Mexico, the Carlsbad Project, 23 tons of alfalfa were grown on 5 acres, with 2.2 acre-ft. of water per acre. In South Dakota, the Belle-Fourche Project, one man reports the following production per acre, 75 bushels of oats, 45 bushels of corn and 200 bushels of potatoes per acre on 4 acres. Another farmer in the same country raised 360 bushels of potatoes per acre. The average yield on about 3,000 acres in this project are given as follows:

Oats, 2,080 acres, average yield 42 bushels per acre, average gross value per acre, $21; corn, 800 acres, 16 bushels per acre, $9.60; wheat, 600 acres, 20 bushels per acre, $18; native hay, 320 acres, 1 ton per acre, $9; potatoes, 80 acres, 90 bushels per acre, $54; alfalfa, 40 acres, 4.5 tons per acre, $18; barley, 40 acres, 23 bushels per acre, $13.75; rye, 40 acres, 15 bushels per acre, $10.50; and garden produce, 10 acres, average gross value, $100 per acre. In addition to the crops named there were some excellent gardens and water melon patches.

All of the farmers agree that considerable capital is needed for the successful prosecution of the work and that as time goes on the yields will be increased.

AMERICAN-MADE TRACING CLOTH is now being manufactured at Providence, R. I. Practically all the tracing cloth used in this country has hitherto been of foreign manufacture, although there have been a number of unsuccessful attempts to make this cloth in the United States. These attempts have failed because of the difficulty of procuring a sufficiently fine grade of linen fabric and the difficulty of producing a satisfactory coating compound. The present enterprise is under the direction of Mr. George T. Nicholls, formerly connected with the tracing cloth industry in Manchester, England, who began its experimental manufacture in this country in 1897. Within the past year, the manufacture of his product, known as "United States" tracing cloth, has been begun in commercial quantities and the product is being handled by the Keystone Blue Paper Co., of Philadelphia.

Samples of the "United States" cloth which have been submitted to us appear to be thinner than cloth of foreign manufacture and more transparent than the grades of foreign cloth in common use. The surface, however, is not quite equal to that of the foreign cloth and it does not stand erasures as well, but this disadvantage is counterbalanced for work not particularly exacting by its lower price, ranging from 10% to 20% less than that of the imported cloth.

A WATERWAY APPROPRIATION BILL was passed by the House on Feb. 20. The bill carries appropriations amounting to $9,971,625. The bill provides for a National Waterways Commission of five Senators and seven members of the House to investigate and recommend to Congress legislation for waterways improvements. Fifty thousand dollars is provided for the expenses of the Commission, which is empowered to employ experts and to investigate waterways in this country and Europe.

THE COST OF CONCRETE BUILDINGS is discussed further by Mr. L. C. Wason in an addition to his paper on that subject read before the National Association of Cement Users, Jan. 12, 1909, and reprinted in our issue of Jan. 14, 1909, p. 42. This addition contains tables of various buildings upon which Mr. Wason's firm has bid, such tables showing the unit cost per cu. ft. of contained area and also the unit cost per sq. ft. of floor area. From these figures, which have been carefully compiled, it is evident that neither of these unit bases are of great value in estimating total costs, although the author claims that the "square foot method is a little safer than the other." The various local items that influence the cost of a building have such different effects that the size of a structure is a poor standard, except for the roughest sort of estimates, by which to measure total cost. The tables show cases of variations of nearly 100% in unit costs of buildings, of practically the same size and built under very similar conditions.

A NEW TYPE OF HIGH-PRESSURE HOSE has been recently placed on the market and seems to possess distinct advantages for some kinds of service. The novel feature is the metallic covering composed of fine, galvanized iron wires arranged in strands of seven wires each. Two series of strands are used, one series forming right-handed and the other left-handed spirals around the hose. Each strand of one series passes alternately over and under the strands of the other series as it crosses them. The pitch of the spirals on common sizes of hose is about 1¾ ins., giving ten strands in each series. The wires in each strand lie flat side by side so that a smoothly-woven, flexible, metallic covering is formed around the inner tube.

The inner tube is of the ordinary rubber and fabric construction and is depended upon to render the hose impervious to water, steam or air. The metallic covering relieves the inner tube from the severe tensile strain due to high internal pressure and also protects it completely from wear and abrasion. The ½-in. hose may be bent to a 3-in. circle without kinking. The strength afforded by the covering makes it possible to reduce the number of plies in the inner tube, and for this reason the metallic hose can be manufactured at a cost slightly less than that for high-pressure hose with a fibrous covering.

With a single covering the hose can be used for working pressures up to 1,000 lbs. per sq. in. and for higher pressures additional layers of metallic covering are added. The Mulconroy Co., Inc., 722 Arch St., Philadelphia, Pa., who are the manufacturers of this hose, are prepared to furnish it to withstand working pressures of air or water up to 10,000 lbs. per sq. in., and it is claimed that such hose would still be flexible. For severe service, such as air-brake and steam connections on railway cars, the hose is provided with an interior layer of the same metallic weave used for the outer covering.

A TYPHOID CARRIER SUCCESSFULLY TREATED BY THE INOCULATION OF TYPHOID VACCINE.—The essential points of the case treated by S. T. Irwin and T. Houston are as follows: The patient was a maid of 26 years, who seven years ago had typhoid fever for seven weeks. On her recovery she resumed her work, but always was easily tired, had frequent headaches, and her stomach was easily disturbed. In the seven years following the fever six people living in the different houses with her fell ill with the fever. It was suspected that she was a "carrier" and she was placed under observation. It was found that the urine contained typhoid bacilli in pure culture and enormous numbers. None was found in the feces. The blood gave a distinct but incomplete Widal reaction. She had a range of temperature from 98° to 100° F. For five weeks she [illegible] tonics, urinary antiseptics, and rest, [illegible] in her condition. A vaccine was [illegible] the typhoid which had been isolated [illegible] was injected with the usual precaution[illegible] first two inoculations the patient lost [illegible] had a higher range of temperature, [illegible] headache, but in the course of three [illegible] to a condition of perfect health, while [illegible] peared from the urine. The authors [illegible] important fact that chronic typhoid [illegible] bacilli in their urine and feces only [illegible] stract in the "Medical Record" of [illegible] Lancet," of London, for Jan. 30, 1909.

THE MANHATTAN BRIDGE floor has [illegible] actively during the past week. The sus[illegible] all in place, the footbridge cables being [illegible] suspenders after hanging the footbridge cables, where it will be needed for the [illegible] on the wrapping wire. Terry & Tench [illegible] suspended superstructure.

DEATHS FROM TYPHOID FEVER in New York State in 1908 numbered 1,368, or 305 less than [illegible] 1907. Tuberculosis of all forms caused 16,521 deaths. This was 11.9% of the total mortality of the [illegible] (138,441), whereas the typhoid mortality was not quite 1% of the total.

A DEPARTMENT OF MECHANO-THERAPY was recently opened at the Vanderbilt Clinic of the College of Physicians and Surgeons, New York City. The equipment comprises some 30 machines to exercise muscles and joints back into normal condition after disease or accident.

Mechano-therapy is both an active and a passive system, used to give strength to tissue, bone and muscle. If a patient is recovering from the effects of a broken arm, leg or shoulder, if he has a flesh wound over which the skin is tightening, if one of his joints is growing stiff after a sprain or break, a mechano-therapeutic machine is called into use and the treatment applied. If a patient is too weak to work actively with one of the machines, his limb is placed in a steel frame, and without the least assistance on his part the needed motion is given by means of a motor. If the patient is able to assist, then the machine is worked by a heavy pendulum, the resistance being increased or diminished as required.

One group of machines serves to effect mechanical operations, such as vibration, percussion, friction and the kneading of different and easily accessible parts of the body. For muscle weakness, atrophy, contraction, thickening of the ligaments and deformities of various kinds there are other machines to help the affected members grow and strengthen by gently stretching them. After a somewhat extended use in Germany this treatment has been recommended for fractures, dislocations, distortions, contusions of joints, scars with contractures, muscular and articular rheumatism, flatfoot, clubfoot, asthma, heart disease, neuralgia, sciatica, intestinal troubles and many other ills.

The consensus of opinion in the countries where mechano-therapy has been used is that recovery is hastened and the period of convalescence diminished 33%, while there are those who go so far as to say that in some hospitals the decrease has been 60%.

THE PRODUCTION OF ROSIN AND TURPENTINE in the United States during 1908 was larger than that for 1907 by 2,408,200 gals. of turpentine and 288,9[illegible] bbls. of rosin, respectively. Due, however, to the decrease in prevailing prices, there was a decrease of $3,704,482.93 in the value of the total combined product for 1908 as compared with that of the preceding year. The average prices in 1908 were, for turpentine, $0.[illegible] per gal., and, for rosin, $4.14 per bbl. The preliminary report of the U. S. Forest Service gives the productions of the eight Southern States producing more than 200,000 gals. of turpentine and 25,000 bbls of rosin as follows:

	1908		1907	
	Turpentine, Gallons.	Rosin, Barrels.	Turpentine, Gallons.	Rosin, Barrels.
Florida	17,030,300	1,932,114	15,572,7[illegible]	1,474,370
Georgia	10,347,800	1,203,059	10,119,5[illegible]	1,173,575
Alabama	3,744,050	446,909	3,544,[illegible]	418,496
Mississippi	2,277,850	277,704	2,232,5[illegible]	255,307
Louisiana	1,696,250	195,804	1,134,[illegible]	126,346
N. Carolina	732,300	131,907	916,4[illegible]	168,361
S. Carolina	559,800	72,125	586,9[illegible]	75,057
Texas	200,650	28,661	74,250	7,909
Total	36,589,000	4,288,283	34,180,8[illegible]	3,999,921
Total value,	$14,112,377.32,	$17,783,509.61		$18,283,-

309.93, $17,317,059.93.

The values are based on market quotations at Savannah, Ga. Figures for production are based upon information secured by a system of correspondence and personal visits to the points of production by agents of the Forest Service.

THE COMMERCE OF THE DULUTH-SUPERIOR Harbor ... Great Lakes during the calendar year 1908 ... 3,797,162 tons, valued at $223,114,320, an increase ... 3% over that of 1890, but a decrease of 31.6% ... of the preceding year, 1907. Among the various ... rried through the harbor hard coal, soft coal, iron ... flour, and lumber all showed decreases in 1908 ... 907, whereas wheat and other grains, copper and ... wed an increase in quantity, although the reduced ... ost of copper reduced the value of that metal ca... The port was open 229 days out of the year. In ... paring the statistics of this lake harbor with the ... some ocean harbors the following statement of the ... engineer officer in charge should be borne in mind:

It is impossible to give precise figures of the marine commerce of the principal ports of the United States for comparison with Duluth-Superior Harbor, for the reason that at ocean ports of the United States as well as of foreign countries, no record of domestic tonnage is kept at the custom houses, whereas on the Great Lakes a record is kept of the total marine commerce; both foreign and domestic. In the principal ocean ports of the United States the tonnage of the local and coastwise trade is the principal part of the marine commerce is several times greater than that of the foreign. Any comparison, therefore, of the relative marine commerce of lake and ocean ports, based solely upon custom house records is, for the reason stated, incorrect and misleading. However, the custom-house records of the marine commerce of ports on the Great Lakes are very incomplete for the reason that no account is kept of the movement of freight or passage of vessels between sub-ports of a district, and as said, in the case of the Duluth and Superior customs districts on Lake Superior, numerous sub-ports are included which do an important business with each other, none of which is required to be reported to the custom-houses, a large amount of the commerce of any particular port is unknown to the custom-hous s. Furthermore, a vessel may enter or clear from the port or any sub-port of a district, report its cargo, and subsequently load or unload the whole or any part of its cargo at any other sub-port of the same district without further action at the custom-house.

THE REBUILDING OF THE EARTHQUAKE-stricken cities of Italy is to be carried on under government direction according to the following report of Mr. A. M. Michelson, U. S. Consul at Turin:

The reconstruction of the cities of Messina, Reggia, Palmi, Bagnara, etc., having been decided upon, the Italian Government, as soon as the debris left by the earthquake shall have been cleared away, will direct the engineer corps of the civil state or a special commission composed of members of that corps to proceed to divide the areas selected for reconstruction into building lots. These lots will be bid for by Italian and foreign contractors who may wish to undertake the construction of new buildings thereon.

Just what arrangement of property rights is to be made is not stated. The report continues:

Anticipating the time when the location and dimensions of the lots will be made known, the Public Works Cooperative Society of Lombardy announces that it will hold a public competition to demonstrate the relative merits of various materials and methods of work and construction adapted for use in the devastated regions. Three prizes will be given: One of 3,000 lire ($579), one of 2,000 lire ($386), and one of 1,000 lire ($193).

From present indications it seems likely that steel and reinforced concrete will be widely used in the work of reconstruction and that the height of buildings will be limited to 10 meters (32.81 ft.)

THE WATER POLLUTION, SEWAGE AND WATER purification bill vesting control of such matters in the State Board of Health, noted in our issue of Feb. 11, 1909 (p. 169), has passed both branches of the Indiana Legislature. It is understood that it will be approved by the Governor. As was stated editorially in the issue named, this legislative act is in line with the advanced sanitary legislation of a number of other states.

THE RELATIVE SIZES OF BRITISH AND AMERI-can streams as related to sewage disposal has often been noted in discussions of sewage purification in the two countries, and might well be given more careful consideration than it has yet received. On this subject we extract the following interesting notes from an address recently delivered before the Commercial Club and Board of Trade of Indianapolis by Mr. Alexander Potter, 143 Liberty St., New York. The subject of the address was "The Growth of the Sewage Disposal Idea in America; What Constitutes Proper Disposal," and some of the remarks were as follows:

The greater size of streams in America has given us a somewhat longer lease of the use of the dilution method of disposal than could be had in England, as there is scarcely a city of any size in America that is not situated on a river or lake of greater magnitude than those of England. The relation between the stream flow and the sewage flow therefore is such a potent factor in purification that the facts recited about English conditions not only show the grave necessities of developing further purification methods in England, but also serve as a basis of difference between the problems which are confronting us and those which have been dealt with in England. So that, while we have thus far had largely to go to England for the best methods of sewage disposal so far developed, I believe that new lines of application of those methods will have to be worked out by the American sanitarian before the best results and the wisest economies will be reached in this country. English practice offers us many *methods* with which to solve our problem, but her achievements have not *solved* American problems.

To make this difference clearer, let us compare the size of some of the rivers in England, and their ability to absorb the sewage or the sewage effluent, with some of our well-known streams along whose banks are very prosperous towns.

The Ohio River at its beginning at Pittsburg has a watershed of 18,735 sq. mi., as opposed to the Thames 4,500. Of this watershed, 11,107 sq. mi. belong to the Allegheny and 7,625 sq. mi. to the Monongahela watershed.

The Miami River has a watershed of 5,400 sq. mi.

The Mississippi has reached the size of the Thames while still 300 miles above the city of St. Paul. Even the Minnesota River, where it joins the Mississippi at St. Paul, is nearly four times the size of the Thames.

The Illinois River has a watershed of 29,013 sq. mi., and the Des Moines of 14,378 sq. mi.—over three times the size of the Thames. Even your little White River at Indianapolis has nearly half the watershed of the Thames at London, and the Thames is the largest river in England.

TELEPHONE TRAIN DISPATCHING.—"As early as 1883 the telephone was used for operating trains on the New Orleans & Northeastern R. R. The service was rendered over a single iron wire for a distance of about 100 miles. This method of operation was followed for over a year. The Lake Erie, Alliance & Wheeling has been operating a line of single-track road for a distance of about 100 miles by telephone exclusively, for a number of years. Thirty trains in each direction per day are handled on this line. The low-grade division of the Pennsylvania R. R., between Columbia and Parkersburg, Pa., 38 miles, has been operated by telephone supplemented by block signals since August, 1906. Many of the western railroads have for years been using the composite telephone to assist in the movement of trains. The Union Pacific are using siding telephones together with signals which are under the control of the dispatcher.

"The first of the present type of telephone dispatching circuits was installed by the New York Central & Hudson River R. R. in October, 1907, between Albany and Fonda, N. Y., 40 miles. This section of the road is on the main line and has four tracks controlled by block signals. The Chicago, Burlington & Quincy R. R. was the next road to instal train dispatching circuits. In December, 1907, a portion of the main line from Aurora to Mendota, Ill., 46 miles, with 11 offices, was equipped. This was followed by others until at the present time there are over twenty telephone dispatching circuits in use on the C., B. & Q. R. R. covering 125 miles of double-track, 28 miles of multi-track, and 1,381 miles of single-track, connecting with 286 stations.

"Other railroads have equipped portions of their lines with telephone dispatching circuits. Among these are the following: Lake Shore & Michigan Southern, Chicago & Northwestern, Michigan Central, Chicago, Milwaukee & St. Paul, Northern Pacific, Delaware, Lackawanna & Western, Great Northern, Chicago, Rock Island & Pacific, Union Pacific, Illinois Central, Canadian Pacific, Atchison, Topeka & Santa Fe, Erie, Virginia, West Jersey & Seashore. Numerous other roads have ordered equipment for this service.

"When it is remembered that this developmnt has occurred in a little more than a year and has been effected without the occurrence of a single accident which can be traced to the use of the telephone, it must be conceded by even the most skeptical that the telephone is at least equal if not superior to the telegraph for this service." [W. E. Harkness, Western Electric Co., before St. Louis Railway Club, Feb. 12, 1909.]

THE "MAURETANIA," the giant Cunard turbine steamship, secured four additional transatlantic records by the trip ending at New York Feb. 18. As noted in Engineering News, Feb. 18, she has made the highest 25-hour day's run of 671 knots. The average speed for the whole run, 25.55 knots per hour, is the best recorded on either short or long course. For the trip ending Aug. 20, 1908, the "Lusitania" averaged 25.05 knots. This last trip of the "Mauretania" was completed in 4 days, 17 hrs., 6 mins. This is 2 hrs., 30 mins. better than any previous record. The fourth record is that of having made the quickest round trip. Between New York and Queenstown on the last trip eastward from New York, between noon, Feb. 26, and noon, Feb. 27, the "Mauretania" logged 607 knots, at an average speed of 26.38 knots per hr., which is the best day's run yet made on an eastbound trip, though not equalling the run of 671 knots at 26.84 knots per hr. on the westbound trip, Feb. 14.

AN UNUSUALLY LARGE WHITE OAK was felled recently in Clinton Co., Ohio. Its circumference at a point 2½ ft. above the ground was 23 ft. and its height was about 70 ft. The estimated lumber content of the trunk was 5,000 board ft., exclusive of an 8-ft. log at the top of the stem which was damaged by cracks and decay. The age of the tree as estimated from a count of the rings was about 500 years. An article containing a detailed description of this tree is published in the "Carriage Monthly," Feb., 1909.

THE EFFECT OF LOW TEMPERATURE on the setting of concrete has been made the subject of a limited set of tests by Mr. Herbert L. Sherman for the Aberthaw Construction Co. The tests were made in the low temperature rooms of the Quincy Market cold storage warehouse in Boston on tension briquettes of neat cement and 1:3 (by weight) sand mortar. All materials including the water used in samples, were left for 25 hrs. in the rooms at temperatures varying from 72° F. to 34° F. The samples were made up in this room and left there until the time for testing, when they were covered up so as to preserve the same temperature, taken to the laboratory and immediately tested. The accompanying table gives the results for all tests where the briquettes showed any appreciable strength. Several specimens were made in the same temperatures as the ones noted in the table, but were allowed to take their initial set in a very low temperature (— 7° F.), for periods varying from 24 hrs. to 7 days, and their final set in 72° F., through the same variation of time. None of these briquettes showed any appreciable strength. The table follows:

Temperature of air and materials.	Initial set.	Final set.	Mixture.	Average tensile strength in lbs. per sq. in. 24 hrs.	7 dys.	28 dys.	3 mos.
72°	45 min.	3 hrs. 50 min.	Neat	290	457	443	759
			1:3	...	168	168	305
41°	45 min.	3 hrs.	Neat	29	514	583	660
			1:3	...	189	221	303
34°	45 min.	8 hrs.	Neat	17	417	508	567
			1:3	...	127	202	249
34°	(room, —7°)	Froze solid	in 10 min.	Cement soft on melting; no set.			
41°	(room, —7°)		Neat				29
			1:3				9

A somewhat similar series of experiments has been carried on and reported to the American Society of Civil Engineers by Messrs. Ernest R. Matthews and James Watson. The report published in the Proceedings of the society, January, 1909, p. 2, was presented for discussion March 3, 1909. It is too long to abstract but the following conclusions should be of interest. All temperatures are recorded in degrees Fahrenheit:

Light frost occurring 24 hours after cement has been gaged (3° of frost, or thereabouts), is detrimental to freshly mixed Portland cement, but only for a short time, and at the end of 28 days it has quite regained its normal strength. If the frost occurs immediately after the cement has been gaged, the effect is more detrimental, and would appear to be permanent. A minimum quantity of water should be added in frosty weather.

Heavy frost (17° of frost, or thereabouts) has a most injurious effect (permanent) upon freshly mixed cement (neat), and cement mortar.

A light frost (3° of frost, or thereabouts) does not affect cement or cement mortar if it has attained 2 days' set previous to the occurrence of the frost.

The detrimental effect of light frost upon cement mortar (1:3) occurs more immediately than upon neat cement, but cement mortar recovers from the ill effects of frost more rapidly than neat cement. At the end of 14 days it has quite recovered.

The mixing of cement or cement mortar with warm water (temperature, say, 100° F.), which is sometimes done in frosty weather, and has been recommended by some engineers, has a permanently injurious effect upon cement and cement mortar.

Neat cement immersed in fresh water immediately after becoming set, and remaining in water, has a much greater tensile strength than when remaining continuously in air, the former being 55% stronger than the latter at the end of 7 days, 50% stronger at 14 days, and 11.3% stronger at 28 days. In 1:3 cement mortar, however, the result is different, the tensile strength being practically the same under both conditions.

17° of frost for 28 days does not kill the process of hardening in the briquette, but only delays it.

It is detrimental to concrete to mix it when the temperature is below 29.3° F., that being the freezing point of cement and concrete.

TEST OF 75-HP. OIL ENGINE.—The following figures were obtained from a 10 × 12-in. three-cylinder Meitz and Weiss oil engine recently delivered to the U. S. Government. The engine drove an electric generator and was equipped with an electrically controlled, automatic compressed-air starting apparatus. The specifications called for starting from a cold condition and running under full load in 60 seconds.

			Kerosene		Water cooling. Temp.	Lbs.
Test. No.	R.p.m.	HP.	Lbs. per HP.	Lbs. per HP.-hr.	C°.	per hr.
1	336.7	79	58.39	.739		
2	336.9	79	58.02	.734	20.5	208.6
3	337.6	81	58.76	.725		
Regulation Tests	341	5				
	338	79				

In tests 1 and 2, the air compressor, for starting, was running idle; in test 3, it was running against 150 lbs. pressure, and was calculated to require 2 HP. specific gravity of kerosene at 60° F. = .7875. These tests were made by the builder, August Weiss, 128 Mott St., New York City, and were a part of an 8-hr., full-load run.

A LONG-DISTANCE TELEGRAPHY RECORD was recently made by the establishment of direct overland communication between London, England, and Calcutta, India, a distance of somewhat over 6,900 miles. This was made possible by the completion of a line between Teheran, Persia, and Karachi, India, a distance of 3,160 miles. There are two automatic relay stations on the new line and 11 between Teheran and London. Direct working has been possible since 1903 between London and Teheran, 3,800 miles.

AN EXPERIMENTAL SEWAGE PURIFICATION plant is to be built by the Sanitary District of Chicago, in connection with an investigation of the sewage from the Calumet River section in the southern part of the district. A drainage canal from the Calumet River to the Chicago main drainage canal (at a point known as the Sag) is projected, in order to free Lake Michigan from the pollution due to the sewage-laden waters of the Calumet. This project has been blocked by legislation on account of the amount of water which would be drawn from Lake Michigan in order to give the requisite degree of dilution to the sewage. The sewage purification plant is intended for partial treatment of the sewage, so that the effluent would require a much smaller amount of water for its dilution. Complete purification of the sewage by such a plant would, it is considered, be too costly, while the Calumet or Sag canal would still be necessary to take care of the river and of the storm-water flow from the sewers. Under these circumstances, partial treatment of the sewage has been recommended, with a reduced draft from the lake for dilution purposes.

The Board of Trustees of the Sanitary District on Feb. 24 voted an appropriation of $10,000 for this purpose, and it had previously appropriated $5,000 to carry on experiments with screens for removing suspended matter in sewage. Definite plans for the plants will not be developed for some time, but at the present time the engineer has in mind the installation of a small septic tank, a sprinkling filter and a biological filter such as is used by Prof. Dunbar at Hamburg, Germany. It is expected that the experimental plant will be located at the 39th St. pumping station of the intercepting sewer system. Mr. Geo. M. Wisner, M. Am. Soc. C. E., is Chief Engineer of the Sanitary District.

Personals.

Mr. W. A. Chase has been appointed City Forester of Springfield, Mass.

Mr. H. B. Thayer, Assoc. Am. Inst. E. E., has become a Vice-President of the American Telephone Co.

Dr. James B. Angell, President for 37 years of the University of Michigan, has resigned. He is 80 years old.

Mr. Henry R. Towne, Past President, Am. Soc. M. E., has been elected President of the Merchants' Association of New York.

Mr. Archibald O. Powell, M. Am. Soc. C. E., has opened an office as a consulting civil engineer in the Central Bldg., Seattle, Wash.

Mr. Frank Trumbull, formerly President of the Colorado & Southern Ry. and of the Colorado Midland Ry., has been elected Chairman of the Board of Directors of the Chesapeake & Ohio Ry.

Mr. A. W. McLimont, Assoc. Am. Inst. E. E., Electrical Engineer of the Public Service Commission, New York City, has resigned to become General Manager of the Chicago & Milwaukee Electric R. R.

Hubert K. Bishop, M. Am. Soc. C. E., formerly with the Department of the State Engineer and Surveyor, Albany, New York, has been appointed First Deputy by the new Highway Commission, State of New York.

Mr. A. B. Shepherd, Director of Public Works of Pittsburg, Pa., has resigned. Mr. Shepherd is Superintendent of the Bureau of Water and will devote the greater part of his time to the reconstruction of the South Side water system.

Mr. Geo. Merritt Ward, Jun. Am. Soc. C. E., formerly with J. G. White & Co., Inc., Rochester, N. Y., has resigned to become General Manager of Construction of the Suburban Construction Co., with offices in the Trinity Bldg., New York City.

Mr. Geo. W. Clark has been appointed Assistant Superintendent of the Central New England Ry., succeeding Mr. F. W. Danks, who has obtained a similar position with the Elgin, Joliet & Eastern Ry. Mr. Clark began work as a brakeman on the Erie R. R.

Mr. L. G. Nilson, Chief Engineer of the Strang Gas-Electric Car Co., New York City, has become President of the Nilson-Miller Co., engineers and machinists, 1300 Hudson St., Hoboken, N. J. Mr. Nilson will continue as Consulting Engineer for the Strang Co.

Mr. W. H. Ham, M. Am. Soc. C. E., has resigned as Chief Engineer of The Central Fireproofing Co. to take charge of the department of concrete engineering with the firm of Messrs. Hollis French and Allen Hubbard, Consulting Engineers, Albany Bldg., Boston, Mass.

Mr. M. P. Higgins, M. Am. Soc. M. E., has been made President of the board of trustees of the Worcester Trade School, which has been recently established by city ordinance. An article on "The Worcester Trade School Plan," by E. H. Fish, was published in Eng. News, Nov. 26, 1908, p. 581.

Mr. Charles M. Spofford, M. Am. Soc. C. E., Professor of Civil Engineering of the Polytechnic Institute, Brooklyn, N. Y., has been appointed Hayward Professor of Civil Engineering at the Massachusetts Institute of Technology, succeeding Mr. George F. Swain, M. Am. Soc. C. E., whose resignation was noted in this column Feb. 4.

Mr. Fred. J. Miller, Vice-President Am. Soc. M. E., became, on March first, connected with the Union Typewriter Co., of New York, with the title of Assistant of the President. He will devote himself especially to matters connected with the manufacturing department of the company, which has factories at Ilion, Syracuse and Bridgeport.

Mr. L. H. Long has been appointed Chief Engineer of the Gila Valley, Globe & Northern Ry. to succeed Mr. E. A. McFarland, whose resignation was noted in this column Oct. 1, 1908. Since that time up to the appointment of Mr. Long, Mr. R. L. Deane, Assistant Chief Engineer, has been in general charge of the railway's engineering work.

Obituary.

William McKelvy, President of the Alpha Portland Cement Co., died Feb. 28 at his home in Pittsburg, Pa., at the age of 70 years. Mr. McKelvy was formerly President of the Atlantic Refining Co. and, at the time of his death, was a director in the Lockhart Iron & Steel Co. and the Pittsburg Foundry Co.

Walter Allen, M. Am. Soc. M. E., Works Manager of the Warner & Swasey Co., died Feb. 8 at his home in Cleveland, Ohio. Mr. Allen was born at Bristolville, Ohio, in 1866. He was apprenticed to the Warner & Swasey Co. in 1885 and has remained in its employ ever since. He became Works Manager in 1904.

Clement Rolla Glass, General Manager of the Andes Tin Co., La Paz, Bolivia, S. A., accidentally shot himself in that city Jan. 2 and died soon afterward. Mr. Glass was born in Martinez, Cal., in 1868 and was educated at the University of California and San José University. He had held various positions in the engineering departments of the Southern Pacific and the Union Pacific R. R., and was for a time Deputy U. S. Surveyor for the district of Nevada. He spent some time in the employ of mining companies in Alaska and for the last ten years has been in Bolivia and Peru.

Thomas T. Johnston, who was Assistant Chief Engineer of the Chicago Drainage Canal during its construction, died Feb. 22 at his home in Evanston, Ill. Mr. Johnston was born at Cincinnati, Ohio, in 1857. His technical education was received at the Rensselaer Polytechnic Institute, of which he was a graduate in the class of 1877. Previous to entering the service of the Chicago Drainage Board he was a U. S. Assistant Engineer and was engaged on work in the Mississippi and Missouri valleys. Upon the completion of his work on the drainage canal, he resigned to engage in private practice, and subsequently directed the construction of the power plants of the Snoqualmie Falls Power Co., near Seattle, Wash., the Enonomy Light & Power Co., Joliet, Ill., and the water-works systems of Savannah, Ga., and Memphis, Tenn. He has been recently in charge of preliminary investigations for the Chicago subway.

Engineering Societies.

COMING MEETINGS.

RAILWAY SIGNAL ASSOCIATION.
March 15. At Chicago, Ill. Secy., C. C. Rosenberg, Times Bldg., Bethlehem, Pa.

AMERICAN RAILWAY ENGINEERING AND MAINTENANCE OF WAY ASSOCIATION.
March 16-18. Annual convention at Chicago, Ill. Secy., E. H. Fritch, 962 Monadnock Block, Chicago.

INTERNATIONAL MASTER BOILER MAKERS' ASSOCIATION.
April 27 to 30. Annual meeting at Louisville, Ky. Secy., H. D. Vought, 95 Liberty St., New York City.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
May 4-7. Spring meeting at Washington, D. C., Secy., Calvin W. Rice, 29 West 39th St., New York City.

AMERICAN ELECTROCHEMICAL SOCIETY.
May 6-8. Annual meeting at Niagara Falls, Canada. Secy., Jos. W. Richards, Lehigh University, South Bethlehem, Pa.

AIR BRAKE ASSOCIATION.
May 11-14. Annual meeting at Richmond, Va. Secy., F. M. Nellis, 53 State St., Boston, Mass.

AMERICAN RAILWAY ASSOCIATION.
May 19. Annual meeting at New York City. Secy., W. F. Allen, 24 Park Place, New York City.

NATIONAL FIRE PROTECTION ASSOCIATION.
May 25-27. Annual meeting at New York City. Secy., W. H. Merrill, 382 Ohio St., Chicago, Ill.

CANADIAN SOCIETY OF CIVIL ENGI[illegible]RS.—At the sectional meeting held Feb. 25, Mr. P. [illegible]reene presented a paper entitled "Phototopogra[illegible] illustrated with lantern slides.

COLUMBIA UNIVERSITY.—A series of [illegible] lectures on "The Gyrostat; its Applications an[illegible]bilities," will be delivered at 5.10 p. m., March 8, [illegible]nd 22, in Room 301, Fayerweather Hall, by Alexa[illegible] Chesaln. The lectures will be illustrated by cha[illegible]d models in operation and will consider the ma[illegible]tical, the scientific and the industrial phases of th[illegible]ject. The lecture of March 8 will be mainly hist[illegible] that of March 15 will deal with the influence [illegible] earth's rotation on the motion of the gyrostat a[illegible]e lecture of March 22 will take up its industrial ap[illegible]ions.

CANADIAN CEMENT AND CONCRE[illegible] ASSOCIATION.—The first annual convention and [illegible]bition is to be held in Toronto, Ont., during the [illegible] week of March. The exhibition of cement and con[illegible] machinery and appliances will be open March 1-[illegible] St. Lawrence Arena and the convention was held [illegible]arch 2-4. The program included the following papers: "Why Sidewalks Fail," Wm. M. Kinney, Chicago, Ill.; "Tests and Inspection of Cement," J. E. Moore, Chicago, Ill.; "Portland Cement Mortars," A. G. Lar[illegible]n, Owen Sound, Ont.; "Modern Methods of Waterproofing Concrete," Lucius E. Allen, Belleville, Ont.; "Field-Made Concrete," Walter J. Francis, Montreal; "Factory-Made Concrete Building Products," Chas. W. Wa[illegible]on, Cleveland, Ohio; "Electrical Equipment for Cement Plants," D. M. McCargar, Belleville, Ont.

CANADIAN MINING INSTITUTE.—The eleventh annual meeting will be held March 3-5 at Montreal. Among the papers to be presented are the following: "The Rescue Apparatus of the Dominion Coal Co.," by F. W. Gray, Sydney, N. S.; "The U. S. Government Rescue Stations, Pittsburg," by J. C. Murray, Toronto, Ont.; "The Electric Furnace, with Special Reference to the Electro-Metallurgy of Steel," by Alfred Stansfield, McGill University; "Mine Accidents," by E. T. Corkill, Inspector of Mines, Toronto, Ont.; "The Mine Waters of Michigan," by A. C. Lane, State Geologist, Lansing, Mich.; "Nitre-Starch, Its Manufacture and Use in Mining and Quarrying," by A. Mosco Vici, Montreal; "What Is an Ore?" by J. F. Kemp, Columbia University; "The Depth of Asbestos Deposits," by Fritz Cirkel, Montreal; "Timber Resources in Mining Districts," by B. E. Fernow, University of Toronto; "Effect of Fungi on Mine Timbers," by James M. Macoun, Geological Survey, Ottawa; "Graphite Concentration," by H. O. H. Brumell, Buckingham, Que.; "The Concentration of Low Grade Magnetic Iron Ore," by G. C. Mackenzie, Kingston, Ont.; "The Geological Investigation of Clays," by Dr. Heinrich Ries, Cornell University.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—At the meeting held in New York City Feb. 23 were discussed the various considerations entering into the problem of specifying safety valves for stationary, marine and locomotive boilers. The requirements of the different types of boilers were outlined, details of safety-valve construction discussed, existing formulas criticized and, in the principal paper of the evening by Mr. Philip G. Darling, Mechanical Engineer, Ashcroft Mfg. Co., which will be published in a subsequent issue of Eng. News, was presented a new formula, or rather a new constant, based on the results of an extensive series of safety-valve tests.

Among those who contributed to the discussion of the safety-valve problem were Mr. Frederic M. Whyte, General Mechanical Engineer, New York Central Lines; Mr. L. D. Lovekin, Chief Engineer of the New York Shipbuilding Co.; Mr. Albert C. Ashton, of the Ashton Valve Co.; Mr. A. B. Carhart, Superintendent of the Crosby Steam Gage & Valve Co.; Mr. A. A. Cary, New York City; Mr. E. A. May, American Radiator Co., Chicago; Mr. F. J. Cole, Consulting Engineer, American Locomotive Co.; Dr. Chas. E. Lucke, Professor of Mechanical Engineering of Columbia University; Mr. H. C. McCarty, Coale Muffler & Safety Valve Co., Baltimore, Md.; and President Jesse M. Smith.

Mr. Darling's paper, after discussing the need for an accurate knowledge of the discharging capacity of safety valves and the inadequacy and uncertainty of the capacity formulas in common use, describes tests made on a number of pop safety valves of different standard makes and suggests a formula for discharge capacity in the general form of Napier's rule, but with a new value for the coefficient of flow through the irregularly shaped discharge openings found in safety valves. The paper was illustrated by lantern slides showing the apparatus used in investigating the lifts of the various valves as regularly installed and that used in regulating the lift to a definite exact value during the tests of discharge capacity. In the investigation of valve lifts, an extreme variation of 300% was found between standard valves of the same nominal size. Formulas in common use take no account of valve lift, but rate all valves of a given diameter at the same capacity. This is obviously wrong since the discharge area of a given valve varies directly with the lift.